MASSACHUSETTS:
AGRICULTURAL EXPERIMENT STATION

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Annual Report

For the Fiscal Year Ending June 30, 1950

The main purpose of this report is to provide an opportunity for presenting in published form recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

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•In charge †At East Wareham ‡At Waltham §On Military Leave

CONTENTS

DEPARTMENT OF AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

The Marketing of Broiler-Hatching Eggs. (A. A. Brown and R. W. Brundage.) For the second year the Department has carried on a study concerned with broiler-hatching egg operations of Massachusetts poultrymen. Last year's study was done on a small scale and served the purpose of familiarizing the enumerators with this relatively new industry. Results from the study were not extensive and therefore served more as a guide to, and background information for, further studies.

This year a sample was drawn from 302 flocks appearing on the Pullorum List published by the Massachusetts Development and Industrial Commission. More than 80 personal interviews were taken, of which 68 were usable. Broiler Cross flocks were concentrated upon.

Broiler-hatching egg sales reached their peak during the last week in September, then declined steadily to 50 percent of the peak figure by mid-December. Receipts of broiler-hatching eggs at Del-Mar-Va from all New England reached their peak in mid-September but declined only 23 percent by mid-December, indicating that Massachusetts may be losing out to other New England states during the fall. Total Massachusetts egg production was increasing during the same periods and sales of eggs in this study reached a peak around November 1; so it is not a matter of production.

Over 70 percent of the producers were shipping broiler-hatching eggs on June 1, when the study began. The rest started shipping at various times throughout the entire season—one as late as December 1. About 35 percent of the poultrymen shipped continuously during the period; nearly 43 percent were cut off completely, mostly during October; and the remaining 22 percent had their shipments interrupted for an average of three weeks. These cut-backs and interruptions were brought about by the buyers, who notified the shippers of their intentions either just before they took effect or not at all. In nearly all cases where the producers shipped continuously, there was some sort of marketing agreement, written contract or other, between the buyer and seller.

The biggest single shift in channels of distribution brought about by these notifications was from the broiler-hatching egg to the auctions. Percentagewise, there was a marked shift from broiler-hatching eggs to other market egg outlets such as to retailers or wholesalers, and many that had the right matings shifted to replacement stock outlets. But compared to the total, it was the egg auction which received the bulk of these unwanted hatching eggs. It should be pointed out that, while it is a contributing factor, this surplus is not the sole cause of a drop in egg prices during the fall.

Approximately 40 strains of birds were found, of which 24 percent were classed as "My Own" strain, indicating that birds had been replaced from the producer's own flock for a number of years. About 14 percent of the birds were one strain of New Hampshires: the Rock-Hamps mating made up a third of the birds in this study, while Rock-Reds made up 20 percent, and straight New Hampshires 18 percent.

Further tabulations are being carried on in preparation for a report which it is hoped will be ready for release soon.

Pricing Eggs on the Boston Market. (A. A. Brown, B. E. Brown, R. W. Brundage, and Alden Manchester, Cooperative Agent, B. A. E., and Harvard University.) This study has developed along four major lines: (1) Interviews with principal handlers of eggs and agencies reporting the egg market, (2) Daily contact with principal handlers for reports on transactions in eggs, (3) Periodic contact with a group of poultrymen for information on egg sales, (4) Transcription of records on transactions in eggs by the major New England cooperative egg marketing associations. Most of the available pertinent data have been brought together and much of the processing has been done.

Most of the near-by eggs entering into wholesale channels during the period of our field work were priced directly or indirectly in terms of the prices reported by the Boston Herald newspaper. Interviews with the trade as well as with some producer groups indicated a lack of enthusiasm for the report—a lack which seemed to stem from their concept of the limited data available to the reporter.

Preliminary analysis of the data indicated several alternatives. First, there is a possibility of improving the present report. Second, there is a possibility of substitution. The U.S.D.A. market news service issues a daily report which includes eggs. The service has features which make it superior to the Herald. Third, the industry in New England might assume responsibility for providing its own statistical services including price reporting.

Custom, trade practice, and chance account for the continued use of the Herald report. Any successor to the Herald will depend largely on the desire of buyers and sellers or buyers or sellers to use something else. The situation is basically a management problem and only incidentally a statistical one (although the statistics could be appreciably improved).

Fluid Milk Prices in Major Northeastern Markets. (A. A. Brown, H. G. Spindler, J. A. Ward, and W. Bredo, Cooperative Agent, B. A. E.) Compilation of the Worcester-Springfield price series was continued and a paper, "Selected Statistics, Worcester Milk Market, June and November 1948," was published for use of interested parties at the Federal hearings held in August 1949 to consider an order for Worcester. Emphasis has been given, however, to the development of comparable f. o. b. and delivered Class and Blend price series for the major markets—Boston, New York, Philadelphia, Baltimore, Washington, and Pittsburgh. Monthly series since 1920 are now available on a 3.7 fat basis for all these points.

Fluid milk and cream (including ice cream) requirements have been determined as of November-December 1947 and May-June 1948 for each of the primary markets plus the major secondaries in the area. Supply areas (milksheds) have been established in terms of these requirements and associated transfer costs.

Marketing Massachusetts Potatoes. (R. A. Fitzpatrick, A. A. Brown, and J. A. Ward.) The first part of the study has been published as Station Bulletin 454. The second part is concerned with the distribution of the local crop, and thus far the principal results pertain to a survey of potato buying practices of retail store operators, made in March 1950. Although the data are essentially subjective, they are considered significant because of the content of the questionnaire and the design of the sample. The data show that Massachusetts potatoes are in a poor competitive status in Springfield stores. Many retailers have the opinion that Massachusetts potatoes are of poor quality, that they are carelessly graded and sized, and that the product cannot be relied upon throughout a season. However, it was found that potatoes from other areas were not consistently of good quality, and were also subject to complaints from customers.

It was found that many retailers were not well-informed on potato grades, and that the majority did not know the varieties of the potato in the store. Further, half of the men interviewed did not know that native potatoes can be obtained during the winter.

The survey also investigated package and varietal preferences of consumers. Considerable data were obtained on package preferences. Data on varieties show that consumers have little knowledge of potato varieties.

A pertinent subject investigated was the possibility of developing a market for low-grade potatoes equitably priced. The survey data show that people in all income areas have been sold on top quality at a top price. The majority of retailers said that the people would not take lower quality potatoes at a lower price. However, some retailers said that people would buy them, because the retailers were actually selling them at the time.

By and large, the retailer is indifferent to the state of origin of potatoes if good quality is maintained. He has to have a dependable supply of good quality because the public will stop patronizing his store if they are given poor potatoes. In many cases, one sale of such potatoes is sufficient to cause the loss of a customer to competitors.

The results of the store survey have been summarized in a mimeographed report entitled "Preliminary Report on a Survey of Potato Buying at Retail in Springfield, March 1950."

The analysis of distribution is continuing with an investigation of disposal of the 1949 Massachusetts crop.

Production Adjustments on Representative Massachusetts Farms. (B. D. Crossmon and H. R. Shaw.) Farm Management case studies are under way on 47 Massachusetts farms. The types of farming receiving the most study to date have been dairy, cranberries, and poultry. Studies of a few vegetable farms have been started. Detailed budgets have been prepared for several farms, indicating the enterprise structure, physical inputs and outputs, and receipts and expenses for a selected base period. The profitability of alternative adjustments on these several farms is being considered through the use of budgets as a base and by making appropriate modifications to prices, to combinations of enterprises, or to rates of using input factors. Five more dairy case write-ups were completed during the year.

A periodical checkup is being made on the progress of the 44 farms which are cooperating with the University of Massachusetts and Harvard University in a dairy farm management project. Seven representative cases have been mimeographed[1] for educational use of agricultural leaders in southern New England. Four cases were written up by B. D. Crossmon while the rest were developed by R. G. Wheeler, project leader at Harvard University.

The study of portable pipe irrigation on hay and pasture crops was begun in 1949. High investment costs ranged from $25 to $160 per acre while total annual costs per acre for irrigating ranged from $15 to $30 or more per acre. Additional

[1] The seven case write-ups selected are reasonably representative of southern New England dairying are:

(1) The One Man Specialized Wholesale Dairy Farm
(2) The Intensive One Man Specialized Wholesale Dairy Farm
(3) The Two Man, Specialized Wholesale Dairy Farm in the Hill Areas
(4) The Intensive Two Man Specialized Wholesale Dairy Farm
(5) The Two Man Dairy Poultry Farm in the Connecticut Valley
(6) The Two Man Dairy Vegetable Farm
(7) The Two Man Dairy Tobacco Farm in the Connecticut Valley

fertilizer is another cost item. The general application of irrigation to Massachusetts dairy farms appears limited.

At four irrigation schools involving 245 leaders, data were presented on fixed and variable costs in irrigation, as well as alternative costs to irrigation. A more complete write-up of irrigation costs in relation to particular farms is in second draft.

The case analyses have led the cranberry and dairy production specialists to evaluate their recommendations more carefully, in view of changing prices, costs, and technology. At cranberry meetings involving 235 operators, information was presented on costs of alternative ways of harvesting and performing other bog operations. Information on production adjustments was presented at regional meetings of leaders of the Farmers Home Administration and Farm Credit Administration.

The case studies provided fundamental material for two formal talks: (1) "Farm Yardsticks" at the Connecticut Rhode Island Agricultural Bankers School, Storrs, Connecticut and (2) "Timely Adjustments for Massachusetts Poultrymen" Poultry Day, University of Massachusetts. Attendance at those meetings numbered 100 and 350, respectively.

Case analyses formed the basis for the following articles:

(1) "Which Will It Be—Lower Income or Increased Efficiency?" Eastern States Cooperator, September 1949, a request for reprint from earlier article in Farm Economic Facts.

(2) "Adjustments to the Drought," Massachusetts Dairy Digest, August 1949.

(3) "Irrigation Possibilities," Farm Economic Facts, October 1949.

(4) "Can Massachusetts Dairymen Meet More Competition?" Massachusetts Dairy Digest, April 1950.

Reprinted in The Market Administrator's Review, Vol. 1, No. 5, June 1950.

DEPARTMENT OF AGRICULTURAL ENGINEERING
H. N. Stapleton in Charge

Forage Handling Investigations. (H. N. Stapleton and Earle F. Cox.)

Barn Hay Drying. Test work on high-volume fans using unheated air has been based upon using fans which would not require more than 7½ h.p. This test work has been continued using new installations at the University Farm and also using the plenum blast tunnel. In the barn installations, studies of air moisture relationship in the mow space, the hay, and the air distribution system have been made in an effort to develop a more accurate evaluation of evaporating capacity. Instrument readings last season indicated both a higher dry bulb and a higher dew point above the hay mass than in the main duct.

Tunnel testing with standard fans has shown that the fit of the fan blade to the mounting ring may change the air delivery as much as 10 percent with the same h.p. requirement. The optimum shape for the discharge tube is also being investigated, for in most installations length of the tube must be limited to one fan diameter. This work combined with studies of air moisture is expected to produce water evaporation ratings for the recommended fan selection for this service.

The "Jayhawk" Stacker which was obtained in an attempt to speed up the loading operation was not satisfactory as purchased. The 8-foot teeth were replaced with 5-foot teeth, but these still did not give satisfactory performance. As nearly as could be determined the friction developed when the juices caused the hay to adhere to the wooden teeth prevented the satisfactory pickup of hay

Air Conditioning of Animal and Crop Storages. (H. N. Stapleton and Earle F. Cox.)

Improvement of Poultry House Ventilation. Several ventilating systems have been under test for the past winter.

1. Forced ventilation using a fan running continuously. A damper was installed to give either full recirculation or full exhaust. A damper motor was used to control the damper with a thermostat setting of 50°F. The maximum temperature differential in a well-insulated pen was 30° and the minimum was 10°. While it did help overcome the effect of sudden changes in outdoor temperature, this system was unsatisfactory because of excessive air change. Damp litter at the front of the house resulted, but the excess air did remove objectionable odors.

2. The same as No. 1 except that Thermopane windows, furnished by the manufacturer, were installed as condensing plates. Moisture removal was planned through condensation of the water on the windows with a partial gain of the heat of vaporization. A very mild season required the development of excessively high humidities within the structure on the available temperature differential, so that this method is not considered to have application in our climate.

3. The same as No. 1 except that two thicknesses of burlap were installed over the fan outlet and a damper was set so that there was a continuous air movement against the burlap. This resulted in approximately 5° higher temperature differential over that obtained by system No. 1. However, the relative humidity was very high and the system was not as satisfactory as No. 1.

4. This system made use of a ventilated space between the rafters, with one inch of fiber glass insulation installed under this ventilated space. No vapor seal was installed on the fiber glass. The purpose of this arrangement was to see whether vapor could be moved through the fiber glass without any great movement of air. The relative humidity was high in this installation.

5. This system made use of a control based upon differential dew point. Two recording instruments were used: one outdoors, and one inside the building. Under this control no air was exhausted unless the absolute humidity inside the pen was higher than it was out of doors. This arrangement is believed to be the best control for drying operations which has been developed to date. It is the only system which gives satisfactory results.

Litter samples were put through the bomb calorimeter and the heat value was determined at 7900 B.T.U. per pound. New instruments provided a measure of the vapor pressure at different places within the house. It was found that the vapor pressure was lower at the fan intake near the floor than at the floor in the front of the house or at the ceiling. In general the temperature at the fan intake was lower than at the ceiling and a 10° differential was frequently recorded.

Improving Tobacco Curing. This project so far has been carried with the help of cooperating farmers. Four installations were made and one additional installation was provided with a recording hygrothermograph. Three installations consisted of 2-blade propeller fans run at low speeds. The fans were installed near the peak of the barn with ductwork and a manually operated damper to permit exhausting air, recirculating air, or any intermediate setting. The operator set the damper according to his observations as the cure progressed. A fourth installation consisted of a Pierson-Moore crop drier. Heat was used for the first few days and then only the fan was used intermittently. Good curing resulted in all installations. Since the season was favorable for curing tobacco, the results obtained do not indicate what may be expected in a cold damp year. Two of the cooperators reported a more uniform cure in the sheds containing these systems than they had in adjacent sheds.

Investigations on Mechanizing Cranberry Production. (Earle F. Cox and F. B. Chandler.) A standard Allis Chalmers Model G. tractor has been obtained and modified for use on cranberry bogs. The two standard rear wheels were removed and replaced with a four-wheel drive, two wheels per side in tandem. This tractor weighs approximately 1500 pounds and develops 8 to 10 drawbar horsepower. The pressure exerted by the tires on the cranberry bog is less than that which would be provided by a man walking across the bog. A duster attachment for this tractor with a 20-foot boom is nearly complete, and a mist sprayer is in the process of development. Plans are being developed to provide attachments on this one tractor for dusting, spraying, pruning, raking, harvesting, ditch cleaning, mowing, and sanding, should sanding prove to be necessary.

Cranberry Harvesting and Packing Investigations. (Earle F. Cox and F. B. Chandler.) Investigations have been made of methods of treating berries at the time of harvesting and during packaging which would have no ill effects on berries. The berries which were given a water treatment before the final drying operation did not keep so well as those which were kept dry during the harvesting operation. The berries which were packaged in a cardboard container having a cellophane window were the best in keeping quality. Gas analysis studies are still in process to determine the effect on berries packaged in polyethylene containers. When the work is completed it will provide a comparison between kraft paper, cellophane, perforated cellophane, cardboard containers with cellophane windows, and the last four plus a treatment of prophylene oxide applied at the time of packaging. Various wet and dry treatments, providing a total of 505 separate tests on the harvesting and packaging of berries, will be tabulated.

DEPARTMENT OF AGRONOMY
Dale H. Sieling in Charge

Influence of Organic Matter on the Availability of Soil Phosphate to Plants. (Dale H. Sieling and Joseph D. Dalton.) Ordinarily native soil phosphate or the phosphate added to soils as fertilizer is fixed in the soil by certain components in forms which are only slightly available to plants. Since acid soils are particularly effective in this fixing process, the efficiency of the phosphate added as fertilizer to these soils is very low. It has been determined that most of the phosphate fixed in acid soils is in the form of either basic iron- or aluminum-dihydrogen phosphate. Both of these chemical compounds have extremely low solubility and thus do not furnish adequate phosphate to crops growing in such soils. The quantity of both iron and aluminum in most soils of the northeastern part of the United States is so great that their capacity to fix phosphates is almost unlimited—at least from a practical standpoint.

Laboratory investigations have shown that certain organic acids are quite effective in preventing the fixation of phosphate by either iron or aluminum and that the most effective organic acids are those normally produced in considerable quantity in the soil by the action of microorganisms on plant residues. These observations suggest that the active decomposition of organic matter in soils produces substances which are effective in freeing fixed phosphate so that it may be utilized by growing plants.

Greenhouse pot experiments have shown that the cumulative yields and phosphate absorption of successive crops of Ladino clover were markedly affected by the addition of decomposable organic matter to the soil. Cultures to which cornstarch had been added at the rate of four tons per acre far outyielded all other cultures. Glucose and sucrose were less effective than starch but caused in-

creases in growth and phosphate uptake equal to or greater than did soluble phosphates at 80 pounds or 160 pounds per acre rates. These results indicate that the substances produced in soils by microbiological decomposition of organic matter are effective agents in making soil phosphates more available to plants.

The Relative Capacity of Plant Species to Utilize Phosphorus from Aluminum and Iron Phosphates. (Walter S. Eisenmenger and Clinton R. Blackmon.) The object of this experiment was to learn the relative capacity of plants of different degrees of development to utilize phosphorus of the relatively insoluble aluminum and iron phosphates.

The plants used, in approximate order of development, were cotton, rape, mustard, bean, clover, buckwheat, tomato, tobacco, and sunflower. Cotton represented the lowest in order of development, sunflower the highest. Each of these nine species of plants was grown in a set of four crocks containing phosphorus-deficient soil. To one, the control, nothing was added; to the other three, primary calcium phosphate, aluminum phosphate, and ferric phosphate, respectively, were added. Each of these 36 plantings was in triplicate.

As might be expected, percentage gain in dry weight was highest in plants grown in primary calcium phosphate. In decreasing order followed those grown in aluminum phosphate, ferric phosphate, and the control.

When the pH of the soil was 6.6 and aluminum phosphate was added, the average percentage gain of the aerial portion of mustard, rape, and cotton—the three least developed plants used—was more than eight times the gain of sunflower, tobacco, and tomato—the three most highly developed plants used. At the same pH, when ferric phosphate was added, the average percentage gain of the aerial parts of the same lower plants was more than ten times that of the three most highly developed plants.

The percentage gain in phosphorus per gram of oven-dried material was greatest in plants grown in soil to which primary calcium phosphate had been added. However, the total uptake of phosphorus was not greater for the less developed plants than for the more highly developed plants. This may have been due to the fact that plants of higher development were in most cases larger than those of lower development.

The behavior of the sunflower was exceptional. Unlike the other higher plants, sunflowers seemed to be able to utilize phosphorus from various sources as well as did some of the lower plants.

The Absorption of Chemical Elements by Plants. (Walter S. Eisenmenger and Karol J. Kucinski.) The addition to the soil of compounds containing "micro" elements may cause plants to increase the uptake from the soil of some of the major elements essential to plant growth.

To each of a series of seven plots was added a compound containing either zinc, copper, calcium, magnesium, manganese, chromium, or molybdenum. To the eighth plot, no compound was added. On each of the plots cabbage and Swiss chard were grown. Calcium, manganese, sodium, potassium, magnesium, and molybdenum were determined in the plants grown on each of the plots.

There was evidence that manganese increased the magnesium and calcium content of Swiss chard; but only sodium was increased by the addition of manganese to the soil where cabbage was grown. Chromium and zinc seemed to have no influence in increasing the other cations; calcium increased the uptake of calcium in both cabbage and Swiss chard; copper increased the potassium content of both plants; molybdenum compounds increased the amount of this element in plants; and manganese compound increased the manganese content, but the increment was smaller than in the case of molybdenum.

Absorption of Chemical Elements by Plants. (Walter S. Eisenmenger and Jean-Marie Lapensee.) It has been found that magnesium ions are taken up by plants in almost direct proportion to the ionic concentration of the soil except in soils where appreciable quantities of potassium ions are present. The presence of potassium apparently reduces the capacity of the plants to take up magnesium.

With this in mind, an experiment was planned to learn the relative availability of magnesium in six different soil series by analyzing the foliage of thirteen species of plants. The leaves were collected from uncultivated areas to which no fertilizer had been applied; most of them from forests. The plants chosen were white pine (*Pinus strobus*), poverty grass (*Andropogon scoparius*), birch (*Betula populifolia*), oak (*Quercus velutina*), chestnut (*Castanea sativa*), beech (*Fagus ferruginea*), poplar (*Populus tremuloides*), goldenrod (*Solidago nemorales*), ash (*Fraxinus americana*), grape (*Vitis riparia*), sumac (*Rhus typhina*), cherry (*Prunus pennsylvanicus*), and maple (*Acer rubrum*).

The soils chosen were Lenox, Worthington, Colrain, Blandford, Agawam, and Chicopee. Lenox soil is weathered from schist and limestone; Worthington soil from Conway schist, biotite, garnet, graphite mica schist, and some limestone; Colrain soil is similar to Worthington with some limestone drift and some sandstone; Blandford soil is weathered from Conway schist, sericilite, garnet, and chlorite; Agawam soil, from mica schist and granite; and Chicopee soil from triassic sandstone and shale.

The leaves of all plants were analyzed for calcium, magnesium, potassium, sodium, phosphorus, and sulphur. The leaves highest in calcium, magnesium, and sodium were those grown in Colrain, Worthington, and Lenox, all of which are weathered from schist and limestone. The potassium content was almost in reverse order. The leaves grown on Blandford soil contained the most potassium, followed in decreasing amounts by those on Worthington, Lenox, Colrain, Agawam, and Chicopee. Plants grown upon Agawam and Chicopee soils absorbed smaller amounts of cations than the same plants absorbed from the other soils studied. Alluvial soils may furnish fewer cations than soils recently weathered from primary rock. Phosphorus, for the most part, was higher in percentage in localities where the magnesium was high. High base exchange of magnesium, calcium, and potassium did not in every case correspond with the high percentage intake by plants. More magnesium was taken up by plants growing upon soils of high pH than by the same plants growing on soils of lower pH.

Field Tests with Magnesium. (Karol J. Kucinski.) It has been felt for some time that certain farming areas, although not showing malignant symptoms of magnesium deficiency on the foliage of plants grown on them, may yet be lacking magnesium for normal growth and maximum crop yield. In order to demonstrate this contention, a series of farm field trials were made in cooperation with several farmers, using various field crops grown on different soils. Because of the abnormally dry growing season the increases in yield on fields where magnesium was applied were not so large as those obtained the preceding year (1948). As much as 26 percent increase in the yield of potatoes was noted where 200 pounds per acre of Epsom salts were applied. An increase of 10 to 43 percent in yield of hay and 3 to 6 percent in yield of onions was obtained with the same treatment. As a result of these tests and similar demonstrations at other stations, soluble forms of magnesium are being used in the formulation of certain commercial fertilizers. Some fertilizer manufacturers guarantee soluble magnesium in all their grades for the 1950 season. It is recommended that 30 to 40 pounds of magnesium oxide in soluble form be added per ton of commercial fertilizer which

is to be used for growing vegetables or field crops on alluvial or glacial outwash soils.

Irrigation Studies and Management of Irrigated Soils. (Karol J. Kucinski, Herbert N. Stapleton, and Dale H. Sieling.) The abnormally dry growing season (1949) has caused considerable interest in portable irrigation systems by tobacco, truck, and dairy farmers of Massachusetts. Studies are being made to investigate all phases of supplemental irrigation as it applies to various kinds of crops, fertilization, changes in soil structure, and effect on diseases and pest control, as well as to yield and quality of product.

Experimental irrigation plots for tobacco, potatoes, onions, cabbage, and millet have been laid out along the Connecticut River. The dry growing season favored yield data obtained from the irrigated plots. Results with set onions showed that without irrigation three-fourths of the area would have been a failure and only half a normal yield would have been harvested on the remaining area. Japanese millet averaged 82 percent increase in yield with four applications of water totaling 3½ inches. The irrigated millet showed about 25 percent increase in germination over the check plot. Irrigated late cabbage yielded 130 percent more than the check, while potato yields increased 16 percent with irrigation. Anhydrous liquid ammonia injected into the system at the time of irrigating a mixed-grass rowen caused an increase in yield of over 100 percent. Application of plant nutrients using the irrigation system will be further investigated. Soil moisture studies, using tensiometers and plaster of Paris moisture blocks, are being made.

A survey was conducted of all the research activities pertaining to supplemental irrigation in the Northeastern States and a report of the survey was made to the Northeastern Soil Research Committee.

Tobacco Yields as Related to Preceding Crop. (Walter S. Eisenmenger and Karol J. Kucinski.) Attempts were made to learn the reasons for the difference in yield and quality of tobacco when various types of plants had been grown on the land during the previous season. The amounts of ceric sulfate and hypoiodite required to oxidize the soil, percentage loss on ignition, lignin content of the preceding crop, and aggregates of soil larger than 4 mm. were used to measure the relative rate of decomposition of plant residues from the various types of plants grown. The plants used for this work were Jerusalem artichoke, sunflower, horseweed, oats, wheat, rye, corn, kaffir, Sudan grass, milo-maize, tobacco, squash, buckwheat, and rape.

Under the conditions of this experiment, the crops which, in rotation with tobacco, usually produced favorable yields of tobacco were those with the most rapid rate of decomposition as determined by the above-mentioned tests. Jerusalem artichokes and sunflowers seemed to produce more organic matter than perhaps any other one species of plants used; but the material from these species decomposed more rapidly in the soil than did that from species of the grass family. The yield and quality of the tobacco crop were better when it followed tobacco, sunflowers, or Jerusalem artichokes than when it followed rye, wheat, corn, Sudan grass, or kaffir.

Use of Process Tankage in Tobacco Fertilizer. (Karol J. Kucinski and Dale H. Sieling.) It is the object of this study to determine whether "Wamco," a processed tankage made from leather scraps in the eastern part of Massachusetts, can be used in the formulation of tobacco fertilizer. Results of fertilizer experiments with shade-grown tobacco, where the organic nitrogen from "Wamco" was substituted for the usual cottonseed meal, showed very little difference

in quality. The percentage of "off-color" tobacco was a little higher on the plots where tankage was used. Trials with "out-door Havana Seed" tobacco showed that where half the organic nitrogen was replaced with "Wamco" tankage the yield and quality were not significantly different from those where all of the organic nitrogen was from cottonseed meal; but where all of the organic nitrogen was replaced by "Wamco" the yield and quality were slightly inferior. If the quality and yield of tobacco is not significantly impaired by the use of "Wamco" process tankage, then a local source of organic nitrogen will be made available to the tobacco grower of the Connecticut River Valley. The saving in cost by not having to transport cottonseed meal from the South would amount to a substantial sum.

Fertilization of Tobacco Seedbeds. (C. V. Kightlinger.) Good seedbeds are necessary for the successful production of tobacco. Proper fertilization is one of the most important factors in the production of good tobacco seedbeds. Important features are the time of fertilization, the kinds of fertilizer used, and the rates and ways the fertilizers are applied.

A series of seedbed plots was fertilized with tobacco fertilizer (6-4-7) in the fall at the rates of 68, 92, 115, and 138 pounds per 1000 square feet of seedbed space; other plots were fertilized in the spring with the same kind of fertilizer at the same rates of application. These treatments were duplicated in another series of plots, except that inorganic fertilizer (7-7-7) was used.

The soil had been plowed at the end of the previous seedbed season and disk harrowed occasionally during the summer. The fertilizers were applied to the fall plots in September, and the whole seedbed was rototilled to a depth of approximately four inches to mix the fertilizers into the soil of the fertilized plots and to prepare the whole area for sterilization. The whole seedbed space was then treated with chloropicrin. In the spring the fertilizers were applied to the spring plots and the entire seedbed space was rototilled as before. Next day (April 20) all plots were seeded with the same kind and amount of seed and watered lightly to cover the seeds.

The germination of seed was good in all fall-fertilized plots, regardless of kind and amount of fertilizers used, except in the plot fertilized with inorganic fertilizer at the rate of 138 pounds, where the stand of seedlings was rather thin, and the subsequent growth of plants was squatty. Germination was somewhat better in the plot fertilized with organic fertilizer at the rate of 68 pounds than in the other plots, but growth was somewhat slower than in the plots fertilized with organic fertilizer at the rates of 92 and 115 pounds. The growth of plants in these latter two plots was the best of the experiment. Growth was noticeably better in all plots fertilized with organic fertilizer in the fall than in corresponding plots fertilized with inorganic fertilizer at the same time.

The germination of seed in all plots fertilized in the fall was better than in the corresponding plots fertilized in the spring, regardless of kind and amount of fertilizer used. It became progressively poorer in all spring-fertilized plots as the rates of fertilization were increased; but was always better in the plots fertilized with organic fertilizer than in the corresponding plots fertilized with inorganic fertilizer. There was almost no germination of seed in the plot fertilized with inorganic fertilizer at the rate of 138 pounds. What seedlings there were in the spring-fertilized plots grew somewhat better in the plots fertilized with organic fertilizer than in those fertilized with inorganic fertilizer.

The results of these experiments show that fall fertilization is much better than spring fertilization of tobacco seedbeds, and that organic fertilizer is superior

to inorganic fertilizer for the purpose. Tobacco fertilizer applied in the fall at the rates of 92 or 115 pounds supplied all the plant food needed to grow good tobacco plants, and there was no need to apply any additional fertilizer in the spring before seeding.

The Improvement of Havana Seed Tobacco. (C. V. Kightlinger.) It is the purpose of this project to improve Havana Seed tobacco and its production in the Connecticut Valley by breeding new strains which combine high resistance to black root rot, common tobacco mosaic, and wildfire with habits of growth and yielding capacity acceptable to farmers and type and quality that are acceptable to manufacturers of cigars.

The breeding program has already met with considerable success. Strains have been produced which are highly resistant to black root rot, have good habits of growth and yielding capacity, and have excellent type and quality. At least 90 percent of the acreage of Havana Seed tobacco in the Connecticut Valley is now planted to some of the improved strains. Their use has contributed to increased yields per acre as well as improvement in quality, which together have resulted in greater profits to growers.

Breeding work is being continued in the hope of making still further improvement in disease resistance, yield, and quality. Particularly, efforts are being made to breed resistance to mosaic and wildfire into some of the strains already produced.

Tests of Spray Materials for the Control of Late Blight of Potatoes. (C. V. Kightlinger and H. M. Yegian.) Numerous new fungicides for the control of late blight of potatoes have been introduced during the last few years. Some of these materials are used extensively by potato growers, give acceptable control of late blight under light to moderate incidence of the disease, are convenient to use, and have little or no harmful effect on potato foliage. However, it is not known how well they might control the disease during years of greater incidence. It was principally to get information on this point that the work was continued this past year. Dithane 14, Dithane Z78, and yellow cuprocide were tested in comparison with Bordeaux 5-2½-50. However, since the incidence of late blight was light in 1949, no information was obtained as to the value of these materials when the disease is severe.

Potato Variety Trials—(Karol J. Kucinski and Ralph W. Donaldson.) Twenty-seven different varieties or strains of potatoes were grown and compared for yield, habit of growth, and resistance to diseases. The eight highest yielding varieties ranging from 439 to 312 bushels per acre were, in descending order, Katahdin, Essex, Cobblers, Bliss Triumph, Chippewa, Pontiac, Erie, and Ontario. Green Mountains ranked twenty-fifth. The drought during the 1949 growing season seriously affected this late variety. The three lowest yielding varieties, ranging from 227 to 172 bushels per acre, were Cayuga, Pawnee, and Narkota. Most of the farmers are growing the high yielding varieties.

Breeding Work with Orchard Grass (W. G. Colby.) Additional plant selections were made from space-planted nurseries of the Finnish late hay strain of orchard grass. Some very late maturing plants have been isolated which are fully a month later than commercial orchard grass. The practical value of these very late maturing plants is doubtful, since extreme lateness is apparently secured at the expense of vigor and productivity.

Field trials with our strain of Finnish late hay continue to give good results. One stand entering its third grazing season still has some Ladino clover present and is still being grazed satisfactorily by cows.

The Relationship of Nitrogen Fertilization to Yields and Leafiness of Orchard Grass. (W. G. Colby.) An area seeded to Finnish late hay orchard grass in the summer of 1947 was laid off in plots with differential nitrogen fertilization treatments with initial applications made in the spring of 1948. A very close correlation was obtained between the rate of nitrogen application and the degree of leafiness and also yield of this strain of orchard grass. At low nitrogen levels few leaves were produced and yields were very low; at medium nitrogen levels (30 pounds of elemental N applied in early spring) more leaves developed and yields were fair; at high nitrogen levels (60 pounds of elemental N) all plants were quite leafy and hay yields were high.

The results of this experiment may explain the poor performance of this strain secured by some other investigators. Where nitrogen levels are low, Finnish late hay orchard grass looks and yields poorly when compared with vigorous early maturing strains. Where nitrogen levels are high, this strain will compare favorably with the early maturing strains in yield of total dry matter and, in addition, will produce a much leafier, better quality forage.

Trials with Cutting, Management, and Nitrogen Fertilization of Timothy. (W. G. Colby.) In last year's report (Mass. Agr. Exp. Sta. Bul. 453: 11-12) favorable results were reported from the liberal use of nitrogen fertilizers on timothy hay sods in late fall or early spring, followed by early cutting (pre-bloom stage), as a means of reducing lodging losses. Good yields (3600 pounds per acre) of high quality hay were produced with no tendency to lodge. Thus far the results were favorable. Subsequent results, however, were unfavorable. The months of July and August in 1949 were abnormally hot and dry. The early-cut plots (June 10) were severely injured. In several instances the stand of timothy was practically lost, with Kentucky blue grass taking its place. The late-cut plots (June 20) while injured by the hot, dry weather, still maintained a fair stand of timothy. If timothy stands are to be maintained, continued early cutting (prior to full-bloom stage) is not recommended. The application of nitrogen after the first crop of hay cut at full-bloom stage had been removed, had no adverse effect on the stand of grass. This method of using larger amounts of nitrogen fertilizer on grass hayland can be followed without encountering serious difficulties.

Onion Breeding. (Hrant M. Yegian.) During the 1949 season, about 80 lots of *Allium cepa* and *Allium porrum*, introduced from Turkey by Mr. J. H. Harlan, were tested. The more promising varieties among the lot were selected for future breeding purposes.

The uniform field test of experimental hybrid onions, set type, was not very successful. Lack of adequate moisture and high temperature during the growing season made it impossible to secure comparative data on the relative performance of different crosses. Some of the inbred lines, with reduced vigor as a result of repeated inbreeding, completely failed to produce any seed under these unfavorable weather conditions. Very few crosses were effected between male-sterile and normal inbred lines for future testing.

Machines are now available on the market for setting onion transplants. Preliminary tests with transplants between male-sterile and sweet Spanish crosses are being carried on in order to find a hybrid best adapted to this locality.

The Evaluation and Use of Flint Lines in Flint-Dent Corn Hybrids. (Hrant M. Yegian.) During the 1949 season, 75 double crosses from the uniform tests of single crosses set up by the Northeastern Corn Improvement Conference were tested. These crosses ranged from early to midseason in order of maturity.

Among them there were few crosses superior in performance to Mass. 62. One of the flint–dent crosses was as early as Maine B. It had a lower percentage of broken stalks and produced more corn per acre than Maine B. The double crosses with best performance are being tested further, preliminary to recommendation for commercial production of the hybrid seed.

Forty-five all-combination single crosses of the U.S. 13 maturity group and another set of 45 single crosses of the Mass. 62 maturity group were tested for performance with respect to various agronomic characters in order to evaluate the selected inbred lines for specific combining ability. Predictions of the performance of all possible double crosses are made on the basis of the data obtained on the performance of the single crosses.

A new set of 45 all-combination single crosses involving 10 flint and dent lines were made with the objective of finding an early maturing flint-dent hybrid.

Development of inbred lines from open-pollinated varieties by selection within self-fertilized lines was continued. A mutant line was isolated containing 35.5 percent total sugar or dextrose in the cornstalks, on a moisture-free basis. Possible use of this line in the production of hybrid ensilage corn will be investigated.

Conservation Projects. (Karol J. Kucinski.)

Fertilization of Beach Grass.—Beach grass plots at Sagamore, Mass., to which commercial fertilizer was applied at various rates during the fall of 1948 showed a definite response to treatment, but not as great as when fertilizer was applied during early spring. Nurserymen dealing with stabilization of coastal sand dunes around airports and coastal resort areas are interested in producing and increasing nursery stock of beach grass transplants. Fertilization of beach grass has increased the quantity and quality of transplants.

Winter Cover Crops for Onions.—The common practice of plowing onion fields in the fall and leaving them bare during the late fall and winter months has, at times, created conditions favorable for the occurrence of dust storms and wind erosion when there is no snow cover. Last fall, blue lupine, barley, and winter rye were sown on onion fields to serve as winter cover crops. In the spring, these fields were plowed. The cover crops were completely buried and no difficulties were experienced in fitting the fields for the planting of onions. The farmers who cooperated in this demonstration were satisfied that it is possible to use winter cover crops on onion fields to protect them against wind erosion and also increase the much needed organic matter in the soil.

Farm Fish Ponds.—Farm fish ponds are a new venture in this region and very little is known about the yield and rates of growth of self-propagating fish in farm ponds which are fertilized. Ponds are being constructed at the Experiment Station for study of the various phases of the subject, and additional ponds with private ownership are being used to enlarge the scope of the study. The management, maintenance, and cost of construction of various types of farm fish ponds has been investigated. Depending on local conditions, farm ponds can be built at a cost ranging from $150 to $1000 and averaging $300 to $400. Stocked fingerling trout grew in one season to about 10 inches in length while black bass grew to 11½ inches in ponds fertilized with 7-7-7 grade commercial fertilizer. A plankton "bloom" comparable to that in southern states was obtained last season with the use of commercial fertilizer. Successful construction of farm ponds will provide water for fire protection, irrigation, farm stock and crop spraying recreation, and will reduce fishing pressure on streams and lakes.

Ever-Ready Water Hole. Valuable farm buildings are often destroyed by fire in the winter in spite of the fact that plenty of water could be made available from ponds or near-by rivers, were they not frozen over. The length of time firemen

"Ever-Ready Hole" In Frozen Farm Pond Aids Winter Fire-Fighting.

need to chop a hole through thick ice after they reach a fire may be a deciding factor in saving a homestead or other farm buildings. A simple "ever-ready hole" that will save valuable minutes when the fire fighting apparatus arrives is shown in the accompanying photograph.

An oak barrel, such as a cider barrel with one end knocked out, is partially filled with a brine solution. The barrel should be floated near the bank in a deep part of a farm pond or stream which can be easily approached by a fire truck. An approach, such as a plank supported on posts, can be made to reach out to the barrel which is anchored with a piece of board to the approach. The barrel may be covered so that small animals will not fall in, and so that rain water will not dilute the brine solution. The exact location of the barrel can be marked by nailing an upright stick to the side of the barrel and having it extend a few feet into the air. This marker will be readily noticed if snow covers the surface of the site.

In case of fire, a fireman with an axe needs only to strike the wooden staves of the barrel about four times and the barrel will crumble, leaving a hole in the thick ice through which the suction pipe can be dropped into the water. During the past two winters, tests were made with such an "ever-ready hole," and it was found that it took about 16 seconds to break up the barrel with four good blows on the staves with an axe.

DEPARTMENT OF ANIMAL HUSBANDRY
Victor A. Rice in Charge

Because of the absence of the project leader on sabbatical leave from September 1949 to April 1950, research work in this department has been relatively inactive.

A Study of the Mineral Elements of Cow's Milk. (J. G. Archibald.) No work was done on this project during the year for the reason noted above.

A Study of Quality in Roughage: Composition, Palatability, and Nutritive Value of Hays as Affected by Curing, Harvesting, and Storing Procedures.

(J. G. Archibald and M. L. Blaisdell.) Field work on this project was continued for the third season in the summer of 1949. Ten lots of hay were involved, representing field curing and barn drying, both baled and loose. Samples of the several lots were taken at cutting time, at loading time, at intervals of three days, a week, and a month in storage, and when fed out. A total of 57 samples was obtained and analyzed for moisture, carotene and sugar, in addition to the conventional fodder analyses. Combined with 51 samples from the 1947 hay crop and 84 from the 1948 crop, the results from all three seasons are now being correlated, interpreted, and prepared for publication. Final conclusions are not yet available, but the results for 1949, insofar as they have been studied, appear to confirm the tentative conclusions published at considerable length in last year's report. A feeding trial with eight cows, similar to the one conducted in the winter of 1948-49 and reported last year was conducted during the winter of 1949-50. Results show no significant difference for milk production between lots of hay from the same field, whether field cured or mow cured.

DEPARTMENT OF BACTERIOLOGY
Leon A. Bradley in Charge

Bacteriological Studies of Sewage Sludge. (James E. Fuller.) This project has been reported previously (Mass. Agr. Expt. Sta. Buls. 449, 1948, and 453, 1949). A publication on the work of this project will appear in the July 1950 number of "Sewage and Industrial Wastes."

Survival of Escherichia coli from Sewage in Soil of Septic-tank Disposal Fields. (James E. Fuller.) The purpose of this project was to determine the extent of penetration of *E. coli* into the soil surrounding septic-tank disposal fields, and the survival of the organism in that environment. A progress report has been made previously (Mass. Agr. Expt. Sta. Bul. 453, p. 18, 1949). Results to date indicate that *E. coli* did not penetrate the soil of the fields studied to any considerable extent, nor survive when inoculated into the soils. That the sewage effluent penetrated the soil to distances substantially greater than the penetration by *E. coli* was shown by two procedures: (1) The use of an indicator, fluorescein, which was added to the septic-tank effluents. (2) The greater sodium-chloride content of the soil adjacent to the disposal lines as compared to that of near-by soil which received no effluent.

The result of this study poses the question of how reliable a laboratory test for *E. Coli* may be as an indicator of safety from pathogenic sewage borne microorganisms. This applies particularly to the testing of water from wells or springs that may be located near septic-tank disposal fields. A positive *E. coli* test would indicate a source of sewage pollution, but a negative test might be misleading. Probably it would indicate safety from such bacteria as those which cause typhoid fever or bacillary dysentery. However, there may be other dangers. It has been shown, for instance, that the virus of poliomyelitis may be present in sewage; but it is not known how far it may penetrate through soil, or survive in it. Two other possible dangers in a similar category are amoebic dysentery and hookworm in regions where these diseases are prevalent.

Effect of Surface-active Agents on Bacteriological Activity in Septic Tanks. (James E. Fuller.) This study was undertaken to accumulate information so that intelligent answers can be given to inquiries that come to this laboratory concerning the possibility that the increasing household use of these soap substitutes may cause septic tanks to function improperly, or fail completely and be-

come clogged. To date 23 surface-active agents (detergents) have been examined. These are distributed among the common chemical groups into which most of the household detergents on the market may be classified. A few of the agents tested have disinfecting as well as cleansing properties. Samples have been set up in 2-quart fruit jars at laboratory room temperature, and tests have been made for ammonia and nitrate nitrogen, hydrogen-sulfide production, settleable solids, total bacteria counts, and numbers of coliform bacteria. Results to date indicate that concentrations of the agents likely to be present in sewage at any given time have no detrimental effect on bacterial activity in septic tanks. On the contrary, a few of the agents seem to increase the numbers and activities of the bacteria.

Types of Organisms Involved in the Spoilage of Home-canned Foods. (John M. Dickerman.) There is considerable loss in home-canning due to inadequate sterilization and defective containers. Estimates of this loss vary from 2 to 10 percent. In the case of inadequate sterilization, heat-resistant bacteria, particularly spore-formers, are the causative agents of the spoilage. Where defective containers are used, spoilage may be caused by a variety of yeasts, molds, and bacteria, which gain access to the jar after sterilization. A knowledge of the types of organisms causing spoilage should provide information as to their source and control.

Specimens of spoiled home-canned foods are obtained, through the cooperation of the Food Technology Department and the Agricultural Extension Service, and examined by standard and special procedures. Viable organisms are isolated. Eventually these organisms will be identified and thermal death rates determined. With such information at hand, it may be possible for those engaged in the teaching of home-canning procedures to re-evaluate the methods now being taught.

At the present time, samples of spoiled corn, green beans, peas, peaches, pickles, and tomatoes are under investigation. The organisms causing spoilage in most of these samples have been admitted to the contents by defective containers or the lack of a proper jar seal after processing. Various types of yeasts, molds, and bacteria, alone or in a variety of combinations, have been isolated and grouped according to their morphology, temperature requirements, and oxygen requirements. Standard and special procedures are being used in an attempt to identify the genus and species of these isolated microorganisms.

The results of these experiments are not as yet significant because of the lack of sufficient samples to give an over-all picture of spoilage in Massachusetts. However, it is felt that a continuation of this project will yield statistically significant data.

Ozone as a Sterilizing Agent for Rural Water Supplies and Dairy Equipment. (John M. Dickerman.) Ozone, maintained at a concentration of 2 p.p.m., has been used to clarify and purify some large municipal water supplies in this country. The use of ozone has gained wide acceptance in Europe for the treatment of water. However, until recently, the generation of ozone has been too expensive to permit its use for the purification of rural water supplies. In a series of limited experiments by others, it has been shown that ozone tends to destroy or eliminate bacteria, algae, tastes, odors, color, and organic matter from water.

The following project is under investigation to test ozone in a known amount as a sterilizing agent for rural water supplies and dairy equipment.

(1) The action, under controlled conditions, of ozone on a variety of bacteria and algae encountered in rural water supplies and dairy equipment.

(2) The ability of ozone to destroy or remove taste, odors, colors, and organic matter from rural water.

(3) The effect of ozonated water for the cleansing of dairy equipment and quarters.

The accepted method for the determination of ozone could not be used for this project because it involves the release of free iodine from a potassium iodide solution by the action of ozone. Free iodine has a marked germicidal effect upon bacteria. Therefore, if this method were used to determine the ozone concentration in a solution containing bacteria, no accurate measurement could be made of the germicidal action of the ozone because of the added germicidal effect of the free iodine. For this reason, a new test for ozone has been devised which uses the oxidization of a dye to the leucobase. By the new method, the amount of ozone can be measured colorimetrically and the test organism is not killed by the dye.

The effect of ozone on a variety of bacteria found in rural water supplies has been studied. Depending upon the organism that was used, 50 to 80 percent of the original number were destroyed by a concentration of 1 p.p.m. of ozone maintained over a five-minute period. However, the intimate dispersion of ozone which is necessary to give the maximum germicidal effect could not be produced in the apparatus that was used for these tests. Therefore, a new type of apparatus has been designed which it is hoped will maintain any desired concentration while producing a good dispersion of ozone.

Data secured to date are not sufficient to be significant and will not be reported here in detail.

The Production of Marketable Organic Chemicals by the Microbic Decomposition of Wood Wastes. (John M. Dickerman.) For a number of years, people have considered employing the microbiological decomposition of wood wastes to produce organic chemicals. Organisms have been studied that utilize cellulose, which is a main constituent of wood. The yield of any marketable organic product has been low. However, experiments of this type have been of such a limited nature that the various factors involved have never been thoroughly understood.

The purpose of this project is to study the microbiological decomposition of wood cellulose in an effort to isolate organisms that will do the work most effectively. An attempt will be made to develop conditions of culturing that will result in yields of organic products in quantities that will be profitable commercially.

This project is in the beginning stages and the data thus far accumulated are not sufficient to justify a detailed report.

DEPARTMENT OF BOTANY
Theodore T. Kozlowski in Charge

Diseases of Plants Caused by Soil-infesting Organisms, with Particular Attention to Control Measures. (W. L. Doran.) To learn more about how the control of clubroot of cabbage by hydrated lime and mercurous chloride, used together, is affected by the soil, a loam was modified by the addition of sand in different proportions. With clubroot severe in all untreated soils, there was no clubroot with mercurous chloride and hydrated lime in loam–sand 1:1 or 1:2, but 30 percent of the plants had clubroot in loam alone. It appeared that clubroot was more readily controlled by mercurous chloride and hydrated lime in a more sandy than in a less sandy soil.

The disease was better controlled by mercurous chloride 0.3 gm. per square foot than by 0.2 gm.

Growth of cabbage plants was retarded by mercurous chloride 0.3 gm. per square foot for 49 days after seeding in sandier soils, for only 35 days after seed-

ing in the less sandy soils. Growth was not retarded thereafter by mercurous chloride in any soil. Growth of plants 97 days after seeding, with clubroot interfering with growth in untreated soils, was much improved by mercurous chloride and hydrated lime in all soils, with most improvement in growth in the sandiest soils.

Ground limestone and hydrated lime were compared for use with and without mercurous chloride in the control of clubroot. There was partial but poor control of the disease by hydrated lime alone; no control whatever by ground limestone alone when both were applied immediately before seeding. First visible infection was more delayed by hydrated lime used alone than by ground limestone used alone. With 100 percent severe infection in untreated soil, there was no clubroot in soil treated with ground limestone 5600 pounds and mercurous chloride or mercuric chloride 33 pounds per acre. It is concluded that under some conditions ground limestone may be successfully substituted for hydrated lime for use with mercuric or mercurous chloride in control of clubroot.

Considerable time was devoted to writing a new Experiment Station Bulletin (No. 455) on "The Control of Some Soil-borne Diseases of Plants by Fungicides Applied in Fertilizer to Soil." It contains the conclusions reached in work under this project on the control of clubroot up to the time of its preparation.

A material, the active ingredient of which is 8 hydroxy quinoline benzoate (2.5 percent), was diluted 1:100 and 2:100 with water and applied to soil before seeding and again when seedlings emerged. It failed to control damping-off, which disease was well controlled by formaldehyde.

Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modifications of Environment. (W. L. Doran.) Phygon (50 percent 2, 3-dichloro-1, 4 naphthoquinone) is the most promising of the fungicides which have so far been used here, either alone or in combination with a root-inducing substance, for the treatment of cuttings of woody plants. Just how this fungicide may be most effectively and safely used with different species is now under investigation, and typical results are summarized below.

Cuttings were given powder-dip treatments with Phygon, usually diluted with talc or with Hormodin No. 1, No. 2, or No. 3. In some cases, such treatments were preceded by the treatment of the cuttings with a root-inducing substance, usually indolebutyric acid, applied by the solution-immersion method.

As compared with untreated cuttings, the percentages of fall and winter cuttings of hemlock, *Tsuga canadensis*, rooting were more increased by Phygon or by Phygon-talc (1:1 or 1:4, by weight in all cases) preceded by solution-immersion treatment with indolebutyric acid than they were by indolebutyric acid thus used alone.

Cuttings of red cedar, *Juniperus virginiana*, rooted in larger percentages after solution-immersion treatment with indolebutyric acid followed by powder-dip treatment with Phygon-talc, 1:4, than they did after treatment with indolebutyric acid used alone.

Cuttings of sweet bay, *Magnolia virginiana*, rooted in larger percentages after powder-dip treatment with Phygon–talc, 1:2, following solution-immersion treatment with indolebutyric acid than they did after treatment with indolebutyric acid alone.

The percentages of cuttings of *Franklinia alatamaha* and of *Rhododendron myrtifolium* which rooted were more increased by powder-dip treatment with Phygon–Hormodin No. 3 (1:4) than by Hormodin No. 3 used alone.

Cuttings of blackalder, *Ilex verticillata*, rooted in larger percentages after

treatment with Phygon–Hormodin No. 2 (1:1) than after treatment with Hormodin No. 2 used alone.

Leaf-bud cuttings of *Rhododendron catawbiense* rooted better after treatment with Phygon–talc, 1:2, than without treatment. Rooting of cuttings of *Cotoneaster horizontalis* was improved by Phygon applied alone as a powder-dip.

A paper on "The vegetative propagation of a few species of elm" by William L. Doran and Malcolm A. McKenzie was published in the Journal of Forestry 47:10,pp.810-812, 1949. It includes a description of the propagation of a disease-resistant elm by root cuttings, a method developed here.

Tobacco Frenching. (L. H. Jones.) While it has been demonstrated and previously reported that a relatively high soil temperature, probably ranging from above to slightly below 32°C., is necessary to induce frenching of tobacco, it has never been demonstrated that the frenching factor must also be present in the soil. Until more is known of the exact nature of this frenching factor, the investigational work must continue to be exploratory and based upon the technique that the symptoms of frenching may be made to appear and be controllable at will by the soil temperature procedure.

Five soils were tested for the frenching factor and, of these, only two were found to be positive. Both of these soils were obtained from moist areas, one near a drainage ditch and the other by a pond. The former produced frenching symptoms in eight days while the latter needed only seven days. The three negative soils were from well-drained areas. However, when a frenching soil was mixed in small quantity with the nonfrenching soils, frenching symptoms were obtained. These tests demonstrated that the negative soils did not contain a naturally anti-frenching factor. On the other hand, when frenching soils are heat-treated with steam under pressure, the frenching factor is destroyed or subdued for the first planting of tobacco. Sometimes the second planting of tobacco was affected with frenching symptoms if the soil was not again steam-treated.

It is becoming apparent that the cause of frenching of tobacco may also affect other plants not closely related to tobacco, but the same environment of a high soil temperature must be present. Certain chlorotic conditions accompanied sometimes with leaf deformities have been noted on ragweed (*Ambrosiaartemisiifolia* L.), oxalis (*Oxalis stricta* L.) and winter squash (*Cucurbita maxima*). These symptoms were induced by maintaining a relatively high soil temperature in a frenching soil and were controllable at will by the soil temperature technique. The squash leaf with its palmate venation had the chlorotic symptoms limited to the border of the leaf. When the above-mentioned plants were grown at a soil temperature of 21°C. or in autoclaved soil at 35°C., the chlorosis was absent. The reaction of these plants corresponds perfectly with the reaction of tobacco grown in frenching soils.

It has been possible to demonstrate that true frenching is not a nitrogen-deficiency reaction by applying nitrogenous compounds to the soil or by spraying the plants with the nitrogen-containing substance, Nu Green. Known nitrogen-deficient plants responded to either by gradually becoming greener and resuming normal growth. True frenching, induced by a high soil temperature, was not alleviated either by the application of nitrogen to the soil or by the spray treatment. On the other hand, there is some evidence that a dilute spray of ferrous sulfate does cause greening of chlorotic leaves under conditions of true frenching. Further tests are necessary to develop this diagnostic technique.

Cuttings made from frenched and nonfrenched plants rooted well in sand and, when potted into a nonfrenching soil, developed normal plants. This substantiates and further proves the point that the frenching factor is not carried by the

plant and is not reproduced within the plant. However, the cuttings of both frenched and nonfrenched plants did resume and acquire frenching symptoms when placed in a frenching soil at a 35°C. soil temperature, but produced normal plants when grown in autoclaved soil at 35°C. or grown at a soil temperature of 21°C.

Chemical Soil Fumigant Temporarily Controls Frenching Factor. (L. H. Jones and L. H. Weinstein) In a preliminary test with a volatile soil fumigant, its effectiveness in preventing frenching was equal to that of pressure-steaming the soil. The soil was known to contain the frenching factor and, after treatment with chemical or steam, was maintained at a soil temperature of 35°C. Plants of Havana Seed tobacco were set in the treated soil as well as in untreated soil which served as a check. The plants in the treated soil showed a marked stimulation in growth, especially those grown in the soil treated with the chemical. The check plants developed the various symptoms that are characteristic of frenching, but the plants in the treated soil did not give any evidence of frenching through the 59 days of the tests. All plants eventually were cut off close to the ground level, and a new set of plants replaced them. This second set of plants frenched in nine days in each of the soils originally treated with the chemical or steam, and the frenching symptoms became very intense as time went on. As yet there is no explanation for the effectiveness of the chemical and steam treatments in eliminating frenching symptoms from the first planting and the complete failure to prevent the frenching in the second planting.

Transmission of Frenching Symptoms from a Frenched Plant to a Healthy Plant. (L. H. Jones and W. H. Weinstein.) There is no previous record that it has been possible to transmit the symptoms of frenching from a frenched plant to a healthy plant. By growing two sets of three tobacco plants each in two containers placed in two adjacent water baths at a temperature of 21°C., it was possible to bring one plant in one container sufficiently close to one plant in the other container to perform an inarched graft. The remaining two plants in each container served as check plants.

After 14 days from making the graft, the soil temperature in one container was raised from 21°C. to 35°C. to induce frenching. On the sixth day, frenching symptoms appeared on the checks and the grafted plant in the high soil temperature container. On the eighth day, the first symptoms of frenching appeared on the grafted plant at the 21°C. soil temperature. No frenching symptoms were apparent or ever appeared on the check plants at the lower soil temperature. As time went on and more leaves developed on the grafted plant at the lower temperature, the frenching symptoms became more intense, except that the second and fifth leaves above the first frenched leaf never showed any symptoms of frenching. These leaves were on the opposite side of the stem from the grafted side. At the conclusion of the experiment, these two leaves were larger than either of the leaves above or below them. Other observations include the less intense symptoms of frenching on the low-temperature plant. The pinhead chlorosis was common to both plants, but the low temperature plant, while producing smaller and narrower leaves than normal plants, did not produce the strap- or string-leaf forms which were present on the high-temperature plant. Terminal growth seemed but slightly retarded on the grafted plant at the low temperature when it had apparently ceased on the high-temperature plant. Axil-shoots on the high-temperature plant were stimulated into growth 22 days after the temperature was raised, but did not start on the low temperature plant until the 35th day. Axillary shoots developed on the check frenched plants at the high

temperature, but none developed on the check and nonfrenched plants at the low temperature. At the conclusion of the experiment, there were 14 axillary shoots on the high-temperature grafted plant and but seven on the low-temperature grafted plant.

Histology of Frenched Tobacco Leaves. (L. H. Jones and E. C. Putala.) It was noted that severely frenched leaves, the strap and stringlike forms, were characterized by lack of palisade cells and that the space normally occupied by spongy parenchyma and intercellular spaces was composed of a mass of uniform cells closely packed, each cell with a relatively large nucleus. Less intense forms of frenching varied in their histology from the above extreme to normal tissues. Previously it has been reported that nitrogen deficiency in the tobacco plant will produce symptoms so closely resembling those of true frenching that they are indistinguishable. The histology of the leaves representing the most extreme types of nitrogen deficiency did not show any complete lack of palisade cells, although such cells were irregular in shape as compared with normal palisade cells. The nuclei of the cells in nitrogen-deficient leaves did not display the enlargement which was common to the extremely frenched leaves. In general the histology of the nitrogen-deficient leaf in its most extreme form was quite similar to the histology of frenched leaves that had not reached the strap-leaved type.

Tomato Leaf Mold Caused by the Fungus Cladosporium fulvum Cke. (E. F. Guba, Waltham.) Hybrids of English forcing tomatoes X Improved Bay State and English forcing tomatoes X Marglobe, all deriving their high degree of resistance to leaf mold from *Lycopersicum pimpinellifolium* U.S.D.A. Plant Introduction No. 112,215, are not so productive or acceptable as Improved Bay State, and no further effort with these types is anticipated.

Tomato No. 44B292, possessing the factor for immunity to tomato leaf mold from *L. peruvianum*, was crossed with Improved Bay State. Selection for immunity to the disease and commercial type in the third generation of this hybrid is now in progress. Improved Bay State is highly resistant, and No. 44B292 X Improved Bay State will be immune to all forms of the tomato leaf mold fungus.

The fall crop of New England grown greenhouse tomatoes is now 90 percent Improved Bay State, and an average increase of approximately 30 percent in yield is estimated. A reduction of 15 percent in fuel cost and 10 percent in cost of cultural practices is estimated as savings where leaf mold is not a contending factor. Only about 5 percent of the spring crop is Improved Bay State, because of the relative unimportance of tomato leaf mold in the spring growing season.

Resistance to Fusarium dianthi Prill. et Del., the Cause of a Serious Carnation Wilt Disease. (E. F. Guba, Waltham.) Our studies show that the varieties John Briry, Woburn, Eleanor, Paragon, and others cited in Mass. Agr. Expt. Sta. Bul. 436 (1946) p. 22, and Bul. 441 (1947) p. 21, have a high degree of resistance to the pathogen.

Numerous crosses of resistant varieties have been obtained. The seedlings have been screened for desirable commercial type by the investigator and cooperating agencies. Some twelve seedlings are acceptable to date and are being propagated further (approximately 12 percent of the total number released to three growers.) Some of them, on the basis of artificial infection studies, appear to be resistant to Fusarium wilt. Four seedlings are being released to the trade by the Sim Carnation Company, Inc.: Mrs. E. F. Guba (10 W; John Briry X Dorothy Napier); Autumn Glow (63 W; Elizabeth Rowe X Helen Hussey); Waltham Pink (48 W; John Briry X Dorothy Napier); and Regal Pink (46 W; Puritan X Helen Hussey).

Two varieties, Eleanor and John Briry, have been selfed and crossed in May and June and numerous seed pods have been obtained. It is proposed in this simplified effort to study the inheritance of resistance to Fusarium wilt among the progeny of this cross and these selfs, and by selfing wilt resistant seedlings for successive generations to establish pure lines for resistance to the pathogene that may be used for breeding purposes.

Control of Diseases of Greenhouse Crops. (E. F. Guba, Waltham.)

Control of Carnation Stem Rot and Wilt Diseases with Top Soil Applications of Chemicals. Stem Rot (*Rhizoctonia solani*), bacterial wilt (*Phytomonas caryophylli*), and Fusarium wilt (*Fusarium dianthi*) have not been satisfactorily controlled by top soil applications of chemicals. Plots not treated performed as well as treated plots. The carnation industry has abandoned the practice after having suddenly accepted it in spite of unfavorable evidence from fundamental research.

Successful control of Rhizoctonia stem rot is being demonstrated commercially by exposing the top portion of the root above the soil when transplanting rather than endangering the stem to infection by burying the roots completely.

Other fungicides are being studied to be sure that the subject will be investigated thoroughly before it is concluded. Disinfesting ratios of chemical to soil can be shown in laboratory studies. Fermate, Phygon, phenyl, and other mercury compounds are disinfesting either to fungi or to fungi and bacteria. Numerous chemicals indicating promise in laboratory studies are being compared in tests in the greenhouse.

Disinfestation of Carnation Cuttings. A suitable disinfestant for carnation cuttings is desired. Potassium permanganate is not satisfactory generally. Parzate, Zerlate, Fermate, and Bioquin Copper 8 have been recommended for dousing carnation cuttings but they are not bactericidal. Phenyl mercury acetates (Tag 331 and Puratized Apple Spray) 1-3786 or ¼ teaspoonful to 1 gallon of water are both fungicidal and bactericidal. Immersion for 30 minutes is disinfesting. Only untrimmed cuttings should be doused. After the treatment the base of the cutting should be snapped or cut off to the next node, then the cuttings planted; otherwise, they will not root well.

Freshening cuttings in water spreads disease organisms. For disinfesting cuttings, phenyl mercury acetate is recommended where bacterial carnation wilt is a factor; otherwise, Parzate, Zerlate, Fermate, or Bioquin Copper 8 may be used.

Investigation of Fungicides which Promise Value in Apple Disease Control. (E. F. Guba, Waltham.) The weather during 1949 was too dry for apple scab. The monthly rainfall for April was 4.90; May, 3.73; June, 0.72; July, 1.08; and August, 1.37 inches.

Phygon XL ½ pound with Epsom salt ½ pound to 100 gallons of water russeted 32 percent of the Delicious apples. Russeting was due to Epsom salt added to prevent Phygon foliage chlorosis. These results suggest that the added Epsom salt might be omitted since 50 percent Phygon XL itself is Epsom salt. Phygon foliage chlorosis could be found on Baldwin foliage. It resulted from the second cover spray on May 25 after warm weather had occurred rather than at calyx, the previous or third application in the schedule. In the current season (1950), Phygon with the recommended amount of Epsom salt added russeted Delicious apples but not Baldwins. Sulfur with lead arsenate and 50 percent wettable DDT russeted Baldwin but not Delicious apples. Phygon foliage chlorosis was quite noticeable on Delicious foliage but only faintly present on Baldwin and McIntosh foliage.

Systematology, Ecology and History of the Monochaetiae and Pestalotiae. (E. F. Guba, Waltham.) This study has been in progress for many years. The confusion in the taxonomy of the genera is being clarified, and the objective is to offer a system of classification capable of utility by the customary research investigator and student in mycology and plant pathology. Presently, all of the species in forty-one orders of hosts in the plant kingdom have been studied critically where specimens could be obtained, or interpreted from description and illustration where type specimens were not obtainable. The species in four orders of hosts remain to be studied.

Several hundreds of specimens have been studied and arranged by this tentative system of classification. By this arrangement approximately 36 species of Monochaetiae and 252 species of Pestalotiae are recognized among forty-one orders of plants. One third of the original number of species have been made synonyms, and approximately another 75 have been transferred to other genera of the Fungi Imperfecti.

All of the species are being organized on the basis of spore form, number of cells and appendages, coloration, and measurable characters independent of the host, and with suitable cross indexing to show host relationships. This method should reduce considerably the number of species and simplify their classification and identification. The effort is purely scientific and taxonomic. It is intended to simplify and clarify the nomenclature of these difficult genera for the mycologist and plant pathologist.

Causes and Control of Decay of Winter Squash in Storage. (E. F. Guba, Waltham.) Bulletin manuscript entitled "Spoilage of Winter Squash in Storage" has been completed and submitted to the Experiment Station Administration. This publication is an illustrated monograph of all of the pathogens and forms of decay involved in the culture and storage of squash, and a presentation of all of the practices involved in the control of spoilage. It is intended to be a helpful source of scientific and practical information to all concerned.

No further work is contemplated.

DEPARTMENT OF CHEMISTRY
Walter S. Ritchie in Charge

Factors Affecting the Vitamin Content of Milk and Milk Products. (Arthur D. Holmes.) Milk is one of the most important agricultural products produced in Massachusetts. Numerous investigators have shown that when milk is drawn from the cow, it contains a significant amount of reduced ascorbic acid, and that the fresh milk produced in the United States during a year contains as much reduced ascorbic acid as is present in the entire citrus fruit crops produced in the United States annually. Unfortunately, a considerable portion of the reduced ascorbic acid present in fresh cow's milk is lost before the milk is ingested by the ultimate consumer. During the past year attention has been directed towards determining factors which are responsible for this loss. As noted in the previous Annual Report, studies in this laboratory show that the rate of loss of reduced ascorbic acid from mare's milk is only a fraction of the rate of loss from cow's milk when both are stored under identical conditions. Studies have been continued with mare's and goat's milk with the hope that such studies might point the way to eliminating the excessive loss of reduced ascorbic acid from cow's milk.

Reduced Ascorbic Acid in Goat's Milk (Arthur D. Holmes, Harry C. Lindquist, and Eugene J. Finnegan.) Sixteen samples of goat's milk, believed to be typical of that produced in Massachusetts, were obtained from goat dairies in the vicinity of Worcester. The amount of reduced ascorbic acid present in the milk varied from 9.4 mg. per liter to 32.5 mg., with an average for the sixteen samples of 17.7 mg. per liter, an amount very similar to that found in fresh cow's milk produced by many commercial dairies.

Decrease of Reduced Ascorbic Acid in Goat's Milk During Storage. (Arthur D. Holmes.) Samples of goat's milk were stored for the usual 5-day experimental period in darkness at 10° C. (50° F.) to test the rate of loss of reduced ascorbic acid. The loss was 61.2 percent for the goat's milk, compared with 65.5 for cow's milk stored under identical conditions. These data suggest a similarity of the conditions in which the reduced ascorbic acid exists in the milk of these two species of ruminants.

Day-to-day Variation of Reduced Ascorbic Acid Content of Mare's Milk. (Arthur D. Holmes.) Twenty-three to 25 samples of milk were collected from each of four closely related Percheron mares. One mare was used during the same stage of two lactations. Identical results were not obtained for these two lactations, and the extent to which duplicate results can be obtained in repeat experiments of this type has been considered. The data assembled from each of the six lactations show that the amount of reduced ascorbic acid in mare's milk fluctuates significantly, and the value obtained from a single sample may lead to quite erroneous conclusions. To secure an accurate picture of the average amount of reduced ascorbic acid in mare's milk, it is essential to collect and assay samples of milk at relatively frequent intervals during the period under consideration.

Loss of Reduced Ascorbic Acid from Riboflavin-enriched Mare's Milk. (Arthur D. Holmes.) Earlier studies in this laboratory have shown that cow's milk contains approximately 10 times as much riboflavin as mare's milk, and that it loses its reduced ascorbic acid 8 to 10 times as fast as mare's milk. Hence, mare's milk was enriched with riboflavin to determine whether the added riboflavin would increase the rate of loss of reduced ascorbic acid during the usual 5-day experimental period. At the end of the period, the mare's milk still retained 85 percent of its original reduced ascorbic acid. These data seem to indicate that riboflavin is not the principal factor in causing the rapid disappearance of ascorbic acid from cow's milk, even when stored in a household refrigerator in darkness.

Rate of Destruction of Reduced Ascorbic Acid in Riboflavin-fortified Pasteurized Milk. (Arthur D. Holmes.) In the previous study, it was found that the addition of riboflavin to mare's milk did not significantly increase the rate of loss of reduced ascorbic acid from the milk. Accordingly, a study was made to determine the effect of adding riboflavin to pasteurized cow's milk upon the rate of destruction of reduced ascorbic acid. Riboflavin was added in amounts of 0.0, 4.0, and 8.0 mg. per liter to 19 weekly samples of pasteurized milk. At the end of 96 hours' storage at 10° C. in darkness, the samples had lost 77, 73, and 69 percent, respectively, of the original amounts of reduced ascorbic acid. Hence, the addition of synthetic riboflavin to pasteurized milk did not significantly increase the rate of loss of reduced ascorbic acid from the milk.

Comparison of the Stability of Reduced Ascorbic Acid in Raw and Pasteurized Milk. (Arthur D. Holmes.) It has been repeatedly shown that reduced ascorbic acid is lost from cow's milk during the pasteurization process. This raised the question whether pasteurization merely destroyed a portion of the reduced as-

corbic acid or whether, in addition, the heat treatment altered the reduced ascorbic acid or the combination in which it occurs in raw milk so that the stability of reduced ascorbic acid in pasteurized milk is different from that in the raw milk from which it was taken. Average values obtained from two series of 20 samples show that the pasteurization process not only destroys a portion of the reduced ascorbic acid in milk, but renders the remaining ascorbic acid somewhat less stable than that which occurs in unpasteurized milk.

Changes in Vitamin Content Coincident with Different Stages and Rates of Maturity of Vegetables Used for Home Consumption. (Arthur D. Holmes.)

Comparison of Light vs. Darkness for Storing Butternut Squashes. (Arthur D. Holmes, Albert F. Spelman, and Robert T. Wetherbee) One hundred thirty well-colored, fully matured Butternut squashes, grown under experimental conditions at the Waltham Field Station, were divided into two comparable lots which averaged 1190.9 gm. and 1192.5 gm. per squash. The two lots were separated by a ¼-inch cardboard partition and were stored for 8 weeks under the same conditions, except that one lot was stored in darkness and the other in controlled, continuous, artificial illumination supplied by four 20-inch white fluorescent bulbs placed beneath a 46 x 49-inch metal reflector which was suspended 24 inches above the squashes. The water content of the squashes remained fairly constant during the experimental period; the reduced ascorbic acid increased during the first 4 weeks and decreased during the second 4 weeks; the carotene increased during both of the 4-week periods; the total sugars increased during the first 4-week period, but not during the second 4 weeks' storage. However, in all instances the amount of reduced ascorbic acid, carotene, and total sugars was larger in the squashes stored under artificial illumination than in comparable squashes stored in darkness. Unfortunately, the storage life of the squashes was short as compared with Hubbard squashes stored under similar conditions.

Darkness Prolongs Storage Life of Butternut Squashes. (Arthur D. Holmes.) Squashes used in this study were produced by Eastern States Farmers' Exchange under carefully controlled conditions maintained in genetic studies designed to develop a commercially desirable strain of Butternut squash. One hundred twenty fully matured, well-colored squashes were divided into two comparable lots which averaged 999.1 and 997.5 gm. and stored for 245 days, one under continuous artificial illumination and the other in darkness. Otherwise, both lots were exposed to the same experimental conditions. Weight and spoilage losses were slightly larger for the squashes stored in light than for those stored in darkness. At the end of the storage period, more of the squashes that had been stored in darkness than of those stored in light were marketable. The storage life of the squashes used in this study was four to five times as long as that of the squashes used in the previous study. The seed which produced the squashes used in this study was treated to eliminate all seed-borne diseases.

The Production of Holocellulose from Nonwoody Plant Tissue. (Emmett Bennett.) In previous work at this station, it has been shown that holocellulose containing all the hemicelluloses may be produced from nonwoody plant tissue. The holocellulose fraction therefore appears to be an ideal substance for use in determining hemicelluloses quantitatively. Isolation of the holocellulose fraction, however, is attended with difficulties. Therefore, in the interests of accuracy and economy of time, it would be desirable to extract and determine hemicelluloses directly without previously isolating the holocellulose. One of the most promising procedures attempted involves the use of perchloric acid as a solvent

for hemicelluloses. The solvent action of dilute perchloric acid on isolated hemicellulose is considerable. Extraction of pentosans in the associated form has been accomplished, but as yet it is not known whether the removal of these products is accompanied by a general fragmentation of the cell wall and hence the removal of other material as well, or whether the solvent action is somewhat specific for the polymers of shorter chain length.

The hemicelluloses of cornstalks were investigated rather thoroughly. The significance of fractionations and some variations in chemical structure are described in Archives of Biochemistry, 27:99 (1950). In general the fraction most difficult to extract was characterized by the lowest percentage content of methoxyl and uronic acid anhydrides, but the highest percentage content of xylan, the greatest number of sugar residues per nonreducing end group and, consequently, the highest apparent molecular weight. The anhydro sugar residues seem to be linked by either the 1, 2 and/or 1,4 glycosidic linkage. Glucose, galactose, xylose, and arabinose were found in all hemicellulose fractions but in different molar ratios. Paper chromatographic techniques were used in separating the sugars in the hydrolyzate mixture and in their quantitative determination.

Investigation of Agricultural Waste Products. II. The Chemical Composition of Certain Wild Plants, with Special Reference to the Content of Alpha Cellulose, Polyuronides, Gums, and Soluble Sugars. (Emmett Bennett.) Plants are storehouses of many important chemicals. A knowledge of the distribution of such compounds is of prime importance in a consideration of chemical transformations and of economic interests. In this investigation plants of no particular economic importance at present are being studied to determine their possibilities as sources of definite carbohydrate fractions listed in the title. Collections and data are too incomplete to warrant further statements at this time.

Yield and Composition of Alfalfa Varieties as Influenced by Rates of Exchangeable Potassium. (Mack Drake and Jonas Vengris.) Three varieties of alfalfa, Kansas Common, Buffalo, and Atlantic, were grown in greenhouse pots on a Merrimac fine sandy loam, low in exchangeable K (potassium) and in total base exchange capacity. The soil was limed to pH 6.5 and was supplied with adequate amounts of nitrogen and phosphorus. Potassium was supplied at three levels of exchangeable K (0.125, 0.25, and 0.5 milliequivalents of exchangeable K/100 gm. soil) by adding K-bentonite to the soil. Both yield and K content of the plants were increased by added increments of K, the composition ranging from 0.3 percent for the low level of K to 1.95 percent K at the high level of exchangeable K in the soil. In the first cutting, at each level of exchangeable soil K, the dried forage of Atlantic alfalfa was 10 to 30 percent lower in K and was correspondingly higher in calcium and magnesium than was the forage from Kansas Common or Buffalo. However, only small differences between varieties in composition were present in the second and third cuttings. At the lowest level of K, Kansas Common in the first cutting produced 22 percent more dry matter than either Atlantic or Buffalo, and this trend in yield differences at the low level of exchangeable K continued in the second and third cuttings. At the higher rates of K, there was no difference in yields between varieties. Relative dry weights of roots after the fourth cutting (300 days) were as follows: at lowest level of exchangeable K–100, 49, and 45, respectively, for Kansas Common, Buffalo, and Atlantic; at medium level of exchangeable K–100, 72, and 82; and at the highest level of exchangeable K–100, 61, and 60, respectively, for Kansas Common, Buffalo, and Atlantic.

The tap roots of the variety Kansas Common were double the size of those of Buffalo and Atlantic. Although Atlantic plants showed considerable branching

and lateral root development, Kansas secondary roots were developed almost as much as those of Atlantic.

Effects of Ammonium Nitrate on Yield and Composition of Hay. (Mack Drake and Wm. G. Colby.) A study of the effect of spring top-dressing of grass–clover and timothy with nitrogen supplied as ammonium nitrate was made on Suffield silt loam (poorly drained) in the spring of 1949. Rainfall during this period was below normal.

The data indicate the great nitrogen requirement of hay lands in Massachusetts. Even when the meadow contained considerable clover with the blue grass and timothy, applied nitrogen increased both yield and protein content of the hay, and the rate of increase of hay yield and protein content per pound of applied nitrogen remained high through the highest rate of nitrogen application (90 pounds acre). The increased nitrogen content of the hay was equal to 65-75 percent of the highest rate of nitrogen applied.

Since these values do not include the nitrogen contained in the increased root growth, one must conclude that in this test the efficiency of ammonium nitrate applied as a spring top-dressing was very high. It is believed that, although the yield might have been higher, the protein content of the hay would have been much lower if the hay had been cut at a date later than June 12.

Yield and Composition of Ladino Clover as Influenced by the Rate and Ratio of Potassium, Calcium, and Magnesium in the Soil. (Mack Drake and Philip B. Turner. In cooperation with Agronomy.) A greenhouse pot experiment in which Ca-Mg-K (calcium, magnesium, and potassium) were supplied to a soil in exchangeable and nonexchangeable forms was conducted to determine the Ca-Mg-K rates and ratios which would give the best yields and composition of Ladino clover. The soil used was a Merrimac fine sandy loam, low in exchangeable bases and in base exchange capacity. The data obtained suggest the following conclusions: Yields of Ladino clover were increased by added increments of Ca-Mg-K bentonites. Although high yields of forage were produced with high levels of exchangeable Ca-Mg-K, the composition was undesirable as the percentage of K was too high and the percentage of Ca and Mg was too low. The combination of high rates of exchangeable Ca-Mg-K with dolomitic limestone increased the yields and improved the mineral composition of the forage.

In a comparison of 12,000 pounds of high-calcium limestone ($CaCO_3$) and 12,000 pounds of dolomitic limestone ($CaMgCO_3$), the yields of Ladino forage were high and were comparable for both treatments. Although no magnesium deficiency symptoms could be detected, plants with high-calcium limestone contained as low as 0.07 percent magnesium, while plants with dolomitic limestone contained 0.45 – 0.65 percent magnesium. The forage from high-calcium lime contained 10 percent more potash than forage from the dolomitic limestone, so that in addition to producing forage with a more desirable mineral content, dolomite should effect more efficient use of potassium. Thus the use of dolomitic limestone is to be recommended in general over the use of high-calcium limestone for Ladino clover. High rates of lime require high rates of potash for best yields. Lime at the rate of 6000 pounds dolomite per acre with 60 pounds K_2O initially and 60 pounds K_2O after each cutting produced forage of desirable (high) calcium and magnesium content. Somewhat higher rates of potash would be required for a grass–Ladino mixture. A comparison was made of 6000 with 12,000 pounds of dolomite per acre when 240 pounds K_2O were applied at planting and again after the second cutting. Forage grown with 12,000 pounds of dolomite contained a higher percentage of calcium and magnesium and 15 percent less potash

than that with 6000 pounds of dolomite. Thus if it is impractical to make small, frequent top-dress applications of potash because of wet land, labor requirements, etc., high yields of forage of more desirable (higher) calcium and magnesium content will be produced, and more efficient use of potash will be made by the use of higher rates of dolomitic limestone.

The Nutrition of Apple Trees. (In cooperation with Pomology and Agronomy.) (Mack Drake, W. D. Weeks, F. W. Southwick, and Dale H. Sieling.) Leaf weight and chemical composition were determined on leaves sampled in July 1949 from a mulch fertility experiment of 16-year-old McIntosh apple trees. In general, the nitrogen content of leaves from heavily mulched plots was decreased and from plots receiving nitrogen as ammonium nitrate was increased as compared to analysis of 1948 leaves. Hay used for mulch was analyzed and applied in amounts to supply nitrogen equal to the amounts supplied by increments of ammonium nitrate.

Dental Caries. (Julia O. Holmes.) The objectives of this study have been to obtain a better understanding of the factors which determine susceptibility to tooth decay and to find methods for reducing or preventing tooth decay in man. Approximately 800 albino rats of a highly caries-susceptible strain have been studied during the year. In the majority of the studies, the rats have been housed in individual metal cages provided with a wide-mesh screen flooring to prevent the eating of excreta or bedding materials, and fed *ad libitum*, unless otherwise specified, for a 60-day period. When two or more rations were being fed, littermates, preferably of the same sex, were placed on each ration. The rations have been composed of 10 to 50 percent "Labco" casein, 38 to 78 percent dextrose, 4 percent corn oil, 4 percent mineral mixture, 4 percent liver fraction #L, and water soluble and fat soluble vitamins in sufficient amounts to assure good growth and health. The standard cariogenic ration contained 15 percent casein.

Casein-rich Rations.—The testing of the 50 percent casein ration for its anticariogenic property has been continued. Twenty pairs of littermate rats have been compared this year, one of each pair receiving the 15 percent casein ration and the other the 50 percent casein ration. The majority of the rats were reared to weaning age by mothers receiving a synthetic ration containing 63 percent sugar during pregnancy and lactation. Sound, caries-free teeth were found in all but one rat receiving the 50 percent casein ration for 60 days; whereas all rats receiving the low-casein standard cariogenic ration had marked tooth decay.

Natural Food Ration.—Additional data have been secured concerning the effectiveness of the standard breeding ration, containing whole milk powder, ground whole wheat, salt, and meat scraps, in preventing tooth decay in the young growing rat. All rats fed this ration, irrespective of whether their mothers had received the breeding ration or a sugar-rich ration during pregnancy and lactation, were completely free of tooth decay. The protein content of the breeding ration approximated 15 percent.

Fluorine.—Fluorine contamination of the casein, as a possible cause of the caries-inhibiting action of casein-rich rations, has been investigated. Fluorine concentrations of 10, 15, 30, 45, 60, and 90 p.p.m. of the standard cariogenic ration have been fed. Rats receiving 60 p.p.m. have not been completely protected against tooth decay; hence, the quantity of fluorine necessary to give the degree of protection observed in the 50 percent casein-fed rats appears to be in

excess of 60 p.p.m. The yellow pigment of the incisor teeth was pale and unevenly distributed in the rats fed fluorine at the 90 p.p.m. level; in those receiving all lower levels (10 to 60 p.p.m.), definite, uniform striations were present in the pigment. In none of the rats receiving the 50-percent casein rations have striations in the pigment layer been detected on careful examination. If the casein was contaminated with fluorine, the amount present must have been less than 10 p.p.m., an amount far too insignificant to protect against decay under the conditions of the experiment. The caries-inhibiting effect of the 50-percent casein rations, therefore, must be due to some factor other than fluorine.

Potassium Oxalate and $(NH_4)_2HPO_4$.—Potassium oxalate, at a level of 0.3 percent or ammonium phosphate at a level of 0.5 percent of the standard cariogenic ration did not inhibit or retard tooth decay in this species of rodent. Higher levels of both are now being investigated.

Methionine.—The caries-aggravating effect of DL-methionine observed earlier in 38 of 44 littermate pairs of rats has not been consistently found in two subsequent groups of rats. In view of the finding that rats receiving this compound eat poorly, especially in the beginning of the feeding period, an equalized feeding test was conducted in which both rats being compared were given the same quantity of food. In 10 of the 13 groups, the methionine-fed rats had definitely more tooth decay than did their controls; the increases in the number of sites of decay and in the total extent of decay, respectively, averaged 40 and 100 percent. Interproximal caries, particularly between the first and second upper and lower molars, occurred more frequently in the methionine-fed rats.

Quantity of Food.—The influence of the quantity of food eaten on the degree of tooth decay observed in the experimental animals was studied in an attempt to determine the cause of the variability in tooth decay found in groups of rats fed identical rations. Twelve groups of rats, each containing three littermates of the same sex and weight were fed the standard cariogenic ration under controlled feeding conditions, in which one rat of each group ate *ad libitum*, and the other two rats received, respectively, 80 and 60 percent of the quantity of food eaten by their "*ad libitum*" littermate. In eight of the nine groups evaluated to date, the rats consuming food *ad libitum* had markedly more severe caries than did their more abstemious littermates; in seven of the groups the "80 percent" rat had higher caries scores than did its "60 percent" littermate. These data point to the need for equalized feeding techniques in studies in which two or more rations are being compared and necessitate a re-evaluation of data obtained with *ad libitum* feeding.

The study of the relationship between the maternal diet and susceptibility to tooth decay in the offspring has been continued. Instead of feeding the standard cariogenic ration which resulted, in the earlier study, in poor reproductive performance, all of the essential nutrients in this ration were increased by 50 percent, the result being that reproduction and lactation were fully equal to that obtained on the standard breeders' ration of natural foods. Fifteen healthy young mature female rats, reared on the standard breeders' ration, were continued on the same ration during their first reproduction, fed the synthetic sugar-rich ration during their second, and in some cases received the standard breeders' diet during the third reproduction. The young were placed on the standard cariogenic ration at weaning and fed for sixty days. The young reared by mothers receiving the natural food ration developed marked caries, a condition consistently observed in this strain of rats Only a few litters reared by mothers on the improved, synthetic sugar-rich ration have been examined for caries; the data collected to

date scarcely justify the current theory that a sugar-rich maternal ration, fed during the periods of tooth development, calcification, and eruption in the offspring, markedly increases the susceptibility of the offspring to dental caries.

Sex Difference.—The records of 100 pairs of brother and sister rats have been studied to determine whether or not a sex factor in susceptibility could be demonstrated. Consistent differences were not observed.

Dicarboxylic Acids.—Aspartic acid, at a level of 2 percent, eroded the dentine on the occlusal surfaces of the teeth in apparently the same manner and to the same extent as does glutamic acid. The abnormal erosion was completely prevented by the inclusion of 30 p.p.m. of fluorine in a ration containing 2 percent glutamic acid, but not by 10 p.p.m. of fluorine, 0.3 percent potassium oxalate, or 2 percent urea.

The Influence of Factors Concerned with the Type of Bedding of the Rats.—Littermate rats were placed in cages (a) directly on sawdust and with access to excreta as well as to sawdust, (b) on a wide-mesh wire screen to reduce the eating of excreta, (c) on the screen and given a cup of sawdust, and (d) on paper with access to both paper and excreta. Consistent differences in tooth decay among the four rats in each group did not occur. The data indicate that in this species tooth decay was not influenced by the chewing or ingestion of excreta, sawdust, or paper. Equalized feeding techniques were not used; because of scattering of food, it was impossible to secure accurate food consumption data for the rats bedded on sawdust.

Suitability of Strain of Rats for Dental Caries Studies.—The highly caries-susceptible rats appear to be as suitable for dental caries studies as are other species of rodents. Carious lesions develop rapidly in the molars, and by the sixtieth day of the experiment are well established but only infrequently have progressed to the stage of cavitation. Fracturing of the cusps, unaccompanied by soft discolored dentine immediately beneath the fracture, is seldom if ever encountered. The extensive carious involvement of dentine without fracturing or cavitation affords proof that the decay is not induced by an initial fracturing. Fully one-third of the total sites of decay occur in the upper molars. Lesions are found in the deep fissures between the cusps of both upper and lower molars in 100 percent of the animals, and in approximately 30 percent of the animals early decay is found on the interproximal surfaces. Lesions are rarely found on the grinding surface or on the tongue side of the molars but have occurred in many rats on the cheek side of the molars at the gingival margin. The latter lesions as well as the interproximal lesions appear as opaque areas surrounded wholly or in part by yellow enamel. The presence of soft yellow dentine at the dentine–enamel junction beneath the opaque areas is proof that the opaque areas are early carious lesions. Cavities at the gingival margin have seldom been found. In those rats fed "soft" diets, decay has been observed at sites which do not undergo decay in rats fed coarsely ground cornmeal.

(These studies were aided by a contract between the Office of Naval Research, Department of the Navy, and the University of Massachusetts (NR 181-485) and by a grant from the National Dairy Council, Chicago. Because of lack of supporting funds for the coming year, the project is being discontinued.)

THE CRANBERRY STATION
East Wareham, Massachusetts
H. J. Franklin in Charge

General. Severe drought and excessive sunshine in July and August prevented the general size of the berries of the 1949 cranberry crop in Massachusetts from

becoming greater than normal, so that the harvested total, 530,000 barrels, was probably considerably smaller than it would have been otherwise. A station forecast of poor general keeping quality for this crop, made in mid-June, was fully verified in the fall, especially with the early varieties. Because of a heavy carry-over in freezers from the crop of the year before, cranberry prices were lower than for many years.

Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin.) The three final parts of the work on cranberry insects were finished and presented for publication. The insect and disease control chart and the cranberry weed control chart were revised again.

The botanical insecticide Ryania was tested fairly extensively, both as a dust and in a spray, as a control for the cranberry fruit worm. It gave a kill of this pest comparable to that obtained with rotenone, but the spray stunted the berries quite noticeably. It is believed that the stunting may have been caused by a wetting agent added to the spray. Ryania failed to kill blunt-nosed cranberry leafhoppers.

Ten percent DDT dust, used at the rate of 50 pounds to an acre, was found to be a more satisfactory control for the green cranberry spanworm than the arsenate of lead spray used heretofore, being less expensive and more lasting in its effects.

Chlordane, applied as a dust and also used in sprays as a 40 percent wettable powder and as an emulsion concentrate, proved altogether ineffective as a treatment for root grubs, even when used in unreasonable excess.

Prevalence of Cranberry Insects in the Season of 1949:

1. The black-headed fireworm did not give much trouble, being rather definitely less abundant than normal.
2. The gypsy moth was about normal in Plymouth County but was well controlled by the growers there, and it gave very little trouble in Barnstable County because of the extensive airplane spraying done in that county by county, state, and federal agencies cooperating.
3. The false armyworm was quite troublesome, having been as abundant only in occasional years in the past.
4. The green spanworm was very widely and severely troublesome, more so than for many years. It was very effectively controlled in many cases by dusting with 10 percent DDT.
5. The cranberry girdler gave very much less trouble than usual and was in fact almost conspicuous by its absence.
6. The cranberry scale (*Aspidaspis oxycoccus*) was troublesome on more bogs than usual.
7. The armyworm (*Cirphis*) appeared on one bog from which the long summer grub flow had been let off on July 15, this being somewhat later than this insect normally appears on bogs.
8. The fire beetle and the red-striped fireworm were not encountered during the season.
9. Bees in general were quite plentiful during the cranberry blossoming period, bumblebees being noticeably much more abundant than usual.
10. The fruit worm was about normally abundant and in general was very well controlled.
11. A species of cutworm (*Hyppa xylinoides*) not heretofore found attacking cranberries appeared in abundance on one bog after late removal of the winter

flood. This worm was working together with other cutworms commonly found after late holding of the winter water.

12. Tipworms were rather noticeably abundant except where they had been controlled by resanding or by dusting with DDT.

13. The cranberry weevil was widely troublesome but seemed to be controlled fairly well in most places by treatment with DDT.

14. The white-marked tussock moth, *Hemerocampa leucostigma* (S. & A.), was found the first week in July to have broken out severely on a few hundred acres of land on the western end of Nantucket Island, the worms being present in nearly all stages of growth. They had cleaned up entirely a very good crop promise on ten acres of cranberry bog by nipping off the blossoms, but had not eaten the foliage severely. The insect had been particularly severe in its attacks on scrub oaks, defoliating them entirely wherever they were abundant. It had also attacked severely swamp blueberry, wild rose, Clethra (sweet pepperbush), clammy Azalea, beach plum, iris, bayberry, and black huckleberry.

Frost Forecasts. (H. J. Franklin.) Afternoon and evening forecasting of frosts for the cranberry bogs was sponsored by the Cape Cod Cranberry Growers' Association and continued as in previous years, there being 213 subscribers to the special telephone service in the season of 1949 and 176 in the season of 1950. Frost warnings, prepared in cooperation with the Office of the United States Weather Bureau at Logan Airport, were sent out by radio through Station WBZ in 1949 and through Stations WBZ, WNBH, WBKA, and WOCB in 1950.

The wind that comes with a sharp rise in the barometer beginning in the middle afternoon or later nearly always continues to blow more or less throughout the following night.

Temperatures on cold, clear nights in the spring on most of the Massachusetts cranberry bogs fall at an average rate of about 1 degree an hour until sunrise after it has been calm for two hours. This rules does not hold for nights in the fall.[1]

Control of Cranberry Bog Weeds. (C. E. Cross.) Two hundred forty strictly experimental tests and about forty commercial scale tests were made with kerosene; Stoddard Solvent (2 types); sodium, ammonium, and isopropanolamine salts of 2,4-D; ferrous sulfate solutions; copper sulfate solutions; borax solutions; and sodium trichloroacetate, with the following results: Post-harvest spraying of kerosene on grasslike weeds adjacent to irrigation ditches was effective and almost wholly selective (leaves of cranberry vines slightly yellowed but no lasting injury). Stoddard Solvent must be sprayed at 600 gallons per acre to control small brambles; 400 gallons per acre for asters, loosestrife, and various rushes and sedges; and 200 gallons per acre for sand spurrey and water purslane. All such spraying must be done when humidity is high, to achieve permanent control, and before cranberry buds have opened in the spring or after harvesting to achieve nearly complete selectivity. The three salts of 2,4-D gave satisfactory control of 3-square grass when 20 percent solutions were lightly wiped on the weed stems. Ferrous sulfate solution, 1 pound per gallon of water, gives excellent control of seedling pitchforks in the cotyledonary stage of development. In the autumn, both ferrous and copper sulfate sprays were found to burn selectively the leaves and stems of white violets, asters, cinquefoil, and various St. John's worts. Further studies must be made to determine the lasting values of such sprays. Borax solutions applied in late summer killed cranberry vines at dosages of 150 pounds per acre or more, and no weeds under test were killed by this

[1] See Mass. Agr. Expt. Sta. Bul. 433, 1946, p. 51.

amount. Sodium trichloroacetate in solution at 80 pounds per acre injured cranberry vines without affecting weeds.

An inexpensive herbarium case has been procured, and plant specimens representing 332 genera and 584 species have been identified and classified in it.

Several tests were made, during the dry summer of 1949, with dilute water-soluble waxes sprayed on cranberry vines at the rate of 200 gallons per acre. Preliminary observations show no detrimental effects to cranberry vine physiology, a rather marked lessening of the damaging effects of dry weather, and an apparent though slight increase in the size of berries where the sprays were applied.

Soil Water Studies. (F. B. Chandler.) Studies of soil water indicate very little or no movement of water horizontally through the peat. When the tension read 2.0 inches or more of mercury (cups set 6 inches in soil), water would not go into the bog from the ditches, and the soil continued to dry out until it rained or the bog was sprinkled. This has been observed in two locations at the State Bog and at Trufant's bog, in studies made in 1948 and 1949. Water in the wells near the tensiometers indicated that the water table was 12 to 17 inches below the surface when the tensiometers read 2.0 inches. The new manometer liquid, acetylene tetrabromide colored with an oil-soluble, sunfast pigment, was very satisfactory in most bogs. In a few bogs that were operated very dry, acetylene tetrabromide was not satisfactory.

Fertilizer Requirements of Cranberry Plants. (F. B. Chandler and William G. Colby.) Data have been assembled in tables for a cranberry fertilizer bulletin, and the manuscript has been started. No difference in yield was found between available sources of nitrogen or between different seasons of application of the fertilizer on Early Black vines. Rot was not increased unless fertilizer was applied in amounts great enough to give excessive vine growth. The present fertilizer studies are with materials to be applied in the flood water, in sprays, in dusts, and with sprinklers. As all of these nearly eliminate the cost of applying the fertilizer and some of them use cheaper materials, it is assumed that growers will be very interested in the results.

Cranberry Breeding. (F. B. Chandler, collaborator, and H. F. Bergman, U.S.D.A.) Cuttings from three new cranberry varieties, named Stevens, Wilcox, and Beckwith, have been set in a number of bogs in Massachusetts for propagation and will be distributed later through the Cape Cod Cranberry Growers' Association. Other selections are still being studied, and selections will be made this fall from the seedlings growing in Massachusetts.

DEPARTMENT OF DAIRY INDUSTRY
D. J. Hankinson in Charge

Sanitizing Agents for Dairy Use. (W. S. Mueller.) The object of this investigation has been to find new and better chemical sanitizing agents for dairy use, and also to improve the effectiveness of some of the commonly used methods of sanitizing dairy equipment.

1. *New Chemical Sanitizing Agents.* (W. S. Mueller.) Preliminary tests indicate that alkyl morpholinium alkyl sulfate may be used as a sanitizing agent. This compound was found to be stable chemically and to have good germicidal properties. In addition to having germicidal properties, this compound has greater detergency power and also greater deodorant properties than the quarter-

nary ammonium compounds now commonly used as sanitizing agents on dairy farms and in dairy plants.

2. *Manner of Germicidal Action of Quaternaries.* (W. S. Mueller and R. M. Burkhardt.) In studying the bactericidal properties of the quaternary ammonium compounds it was found that here, as well as in the use of many other germicidal agents, a few organisms survive the effects of the germicide under a given set of conditions. The object of this study has been to find a satisfactory explanation for the survival of these organisms. The possibility that the bacterial population is comprised of components of different degrees of resistance was investigated. Approximately two hundred tests were made, subjecting *E. coli* organisms to a quaternary germicide, to determine whether the first subculture differed appreciably in resistance from the parent cultures. It was found that the subcultures were less resistant to the germicide than the parent cultures. The possibility that the quaternary causes the organisms to clump or agglomerate, thus protecting the organisms in the center of the clumps from the germicide, was also investigated. So far the results indicate that clumping is not a major cause for a few organisms surviving the killing action of a germicide when the majority of organisms are killed.

3. *A Micro Method for Evaluating Germicides Determining 100 Percent Kill.* (W. S. Mueller.) Methods for evaluating quaternary germicides usually involve a comparison of the time required to kill a definite percentage of standard test organisms. Some methods make provision for an end point of 100 percent kill while others have end points which are slightly less than 100 percent. An end point of 100 percent kill is very desirable if it can be determined accurately. This investigation was made for the purpose of developing a better method for determining 100 percent kill. A micro method was developed which is based on the use of a magnetic stirrer and also on a micro procedure for making the agar plate colony count. Advantages of the new micro test method are:

(1) It is conveniently and rapidly performed.

(2) A minimum amount of incubation space is required for a large number of tests.

(3) The incubation for determining surviving organisms is made in the test dish, thus simplifying the procedure.

(4) Small amounts of materials are required. Only 1 ml. of nutrient agar is needed for each micro petri dish.

This method has been published in Modern Sanitation, Vol. 2, No. 6, pp. 45-46, June 1950.

4. *Detergent-Sanitizers.* (W. S. Mueller.) A new departure from the common method of washing and then sanitizing dairy equipment is the use of a detergent-sanitizer which combines cleaning and initial sanitizing in one operation. This new procedure is being investigated for its effectiveness, and it is concluded that while detergent-sanitizer combinations have not been perfected, they do appear promising enough to receive further attention.

A paper on detergent-sanitizers was published in Milk and Food Technology, Vol. 12, No. 4, pp. 240-243, July-August 1949.

5. *Sanitization of Dairy Utensils by Heat.* (W. S. Mueller and W. T. Geenty.) Warm water is essential for proper washing of dairy equipment. Also hot water and steam have certain advantages over chemical agents for sanitizing dairy equipment. It has always been a major problem to supply these economically on dairy farms in sufficient quantities. Recently there has been introduced in

New England a small equipment unit consisting of a heater (available for burning natural or manufactured gas, stove oil, kerosene, or Diesel oil), a two-compartment wash sink, and a sterilizing cabinet. The heater will produce either hot water or low-pressure wet steam. The chief purpose of this investigation is to determine how far this equipment will go in solving the dairy farmers' hot water and heat sanitization problems. Efficiency test studies have been made using bottled gas as the fuel supply, and the heater was found to produce a continuous supply of hot water or steam at approximately 70 percent efficiency in fuel consumption. By engineering standards, this is considered to be very good. It was also found that the heater would produce hot water or steam within less than two minutes after lighting. While studies have not been completed, the results so far obtained indicate that this type of equipment would serve a very useful purpose on dairy farms.

Effect of Certain Antioxidants on the Flavor and Keeping Properties of Milk and Some of Its Products. (W. S. Mueller and E. J. Finnegan.) The object of this study has been to obtain further information on the antioxidative properties of various materials when added to dairy products. Investigations were also made to find a tool which is better than the Swift's Fat Stability Apparatus for measuring the effectiveness of an antioxidant in dairy products. Such a tool which has been investigated is the "Stinkometer." This apparatus has been used by other investigators for measuring the volatile reducing substances in various foodstuffs, as an index of the degree of spoilage. This method is based on the use of aeration for determining the volatile constituents.

In this study the outlet of the aeration of the Swift Fat Stability Apparatus was connected to the inlet of the reaction vessel of the "Stinkometer" apparatus. By this means it was possible to obtain data on the two different test apparatus by aerating one sample of the dairy product under investigation. The "Stinkometer" value proved to be more sensitive to oxidative changes in aerated samples of butteroil than the peroxide value. This was true especially during the initial stages of the induction period which is the critical period for noting changes.

Further studies with cacao shell corroborated earlier findings that this material contains a potent antioxidative substance.

DEPARTMENT OF ECONOMICS
Philip L. Gamble in Charge

Transfer of Ownership and Its Effect on Agricultural Land Utilization. (David Rozman.) Work on this project has continued with the gathering of basic data and the analysis of the material for completion of the study. Seven towns in scattered locations, with different types of farming, were covered by the investigation. Changes of land ownership were examined for the 9-year period 1940-1948, and all land transactions of 3 acres and more were taken into consideration. The principal points and conclusions revealed by the study are as follows:

1. The total number of land transfers, including resale of some properties, amounted to about two-thirds of the individual land holdings over the 9-year period.
2. The number of land transfers has been increasing since 1940 and reached its climax in the two postwar years, 1946 and 1947.
3. Advanced age of former farm owners and demand for land on the part of returning veterans were contributing factors in the high rate of land transfer in the postwar period.

4. The increased sales of part-time farming and non-agricultural land holdings in the early post war period were due mainly to the demand for housing accommodations in rural areas by people from urban communities.

5. As a result of all transactions, the amount of land in farming has declined by about the same area as it increased in part-time farming; the land area in other uses has not shown any appreciable change over the 9-year period. The most important result, therefore, has been the transfer of land from farming to part-time farming.

6. Although a certain number of transactions involved purchases for the purpose of investment in rural land or for resale at higher prices, neither of these factors attained great importance in the total transfer of property.

7. Most of the sales of land held by banks and corporations occurred in the early period of the war, as soon as the land market became favorable.

8. Non voluntary sales were very few throughout the period. Only 10 farms with 1,155 acres were involved in forced sales, all in the early years. No farm was sold in these transactions after 1944.

9. Purchase of land to be added to existing farms has been an important factor in the transfer of ownership. There were 83 transactions for that purpose, involving 2,397 acres of land.

10. The majority of farms purchased in the early war period were on a cash basis. In the post war period the purchases of farms on a mortgage basis were more frequent.

11. Although the total land area included in farms in Massachusetts has declined during the last decade, the productive capacity has actually increased. This has been due both to better treatment of farm lands in general and to measures of conservation and rehabilitation of land in farms.

12. The higher rate of transfer in farm land ownership has contributed towards better treatment of land resources. This conclusion is based on data indicating greater participation in land improvement and soil conservation programs on the part of new owners.

DEPARTMENT OF ENTOMOLOGY
Charles P. Alexander in Charge

Investigation of Materials which Promise Value in Insect Control. (A. I. Bourne and W. D. Whitcomb.) The cooperative project with the Dow Chemical Company was continued. Dormant applications were made on cultivated blueberries with Dow Co. Dn-289 and a tank-mix Superior oil emulsion, for the control of the blueberry Lecanium in the small area of the college planting in which the pest still persisted. As the season developed and the plants came into foliage, no injury from either type of spray was observed. The unsprayed barrier rows also showed no evidence of winterkilling. This was in contrast to 1948 when severe winterkilling of tips took place and raised some uncertainty in the minds of observers whether Dn-289 had or had not caused the damage or aggravated the injury. In a spring following almost no winter injury, neither Dn-289 nor oil emulsion caused any damage, which would seem to settle the question of safety of Dn-289 on the plants. Subsequent counts of scale showed 8 percent mortality on unsprayed check plants, 87 to 88 percent mortality on plants sprayed with Dn-289, and 93 to 94 percent mortality on plants sprayed with oil emulsion; indicating a very high winter survival of the scale, very satisfactory control by both materials applied, and very little significant difference between the two types of spray used.

For control of overwintering aphid and red mite eggs, Baldwin and McIntosh trees in Block A were sprayed with Dn-289 at 2 quarts per 100 gallons. Buds were in dormant stage; weather, fair and clear; temperature 60°F. Trees showed a comparatively light carry-over of aphid eggs and even fewer red mite eggs. The first newly hatched aphids were found in the college orchard and commercial orchards in the vicinity, April 4 and 5. Subsequent counts showed 50 aphids per 50 buds on unsprayed Baldwins and 235 aphids per 50 buds on unsprayed McIntosh. No living aphids were found on sprayed trees. The number of red mites which hatched in this block was too low to give conclusive results.

Pear Psylla Control—Parathion (25 percent wettable powder) at ½ pound per 100 gallons and Dn-289 were applied as the blossom buds were breaking and both gave excellent control of pear psylla. Adults, eggs, and nymphs were killed. Counts just previous to application showed numerous psylla flies, and eggs varying in number from 285 to 2655 per 25 fruit spurs. Subsequent examinations showed that practically all active stages were killed and the eggs failed to hatch. It is a matter of record that no further treatments for psylla control were needed during the remainder of the season in that orchard.

Parathion applied at approximately monthly intervals during the summer to different varieties of pears caused no injury to any variety, even Bosc. An application as late as August 12 caused no visible injury to foliage or to ripening fruit.

Oystershell Scale Control.—Dn-289 at 3 quarts per 100 gallons was applied in the dormant season at a private estate in Amherst. The infestation was moderate to heavy, but no deep encrustation of scale was present. Some pruning of dead branches had been done previous to spraying. Overwintering eggs were hatching in late May, just before the 30th. Rather cold weather during the last week of May slowed down somewhat the appearance of young. The property owner reported that he was unable to find any young scales. Examinations made by us in late June and later in the summer indicated that very little hatch had occurred. The new terminal growth was practically free of scales.

Examination of lilac plantings on the lawn of one of the staff in West Pelham, sprayed with Dn-289 in 1947, showed no scales on the terminal growth of either 1948 or 1949. The owner reported that previous to 1947 scale had been so prevalent in his plantings of lilacs that it had been necessary to do considerable pruning of dead branches each spring, including that of 1947. Nothing of the sort had been done in either 1948 or 1949, indicating that the infestation had been practically eliminated.

Investigations of Materials Which Promise Value in Insect Control. (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.)

Effect of Synergized Rotenone-Pyrethrum on Mexican Bean Beetle.—Three applications to string beans of dusts containing 0.25 percent rotenone and 0.05 percent pyrethrins with 0.5 percent piperonyl cyclonene or n-propyl isome reduced damage to bean foliage by the Mexican bean beetle by 82 percent during the most active period, and by 91 to 94 percent for the season. A dust containing 0.12 percent pyrethrins and 0.75 percent piperonyl cyclonene was less effective.

Insecticides for Squash Borer Control.—The natural infestation of squash borer in the experimental plantings was 5.94 borers per vine, and the greatest infestation was in the Buttercup variety. Under these conditions the most effective insecticidal treatment was spraying with 50 percent methoxychlor wettable

powder at the rate of 3 pounds in 100 gallons of water. Synergized pyrethrum-rotenone dust and 5 percent chlordane dust were reasonably effective, but the chlordane caused injury to the foliage of the younger plants. Parathion powder as a spray and tetraethyl pyrophosphate as a dust did not have sufficient residual action to give protection between treatments made at weekly intervals.

Control of Cabbage Maggot—In the experimental planting in 1949, 65 percent of the cabbage and cauliflower plants were commercially injured by the cabbage maggot. There was no outstanding difference in the infestation on cabbage and cauliflower.

When the insecticides were applied as soon as the first eggs were found and one week later, if repeated, the following dusts gave 95 percent or better protection against commercial injury: 5 percent chlordane dust—1 and 2 applications; 3 percent chlordane dust—1 and 2 applications; 1.5 percent Lindane dust—2 applications.

From a practical standpoint, the 3 percent chlordane dust was as effective as the 5 percent dust, but 1 percent chlordane dust was unsatisfactory and permitted 50 percent commercial injury on cabbage.

Excellent control was also obtained from a suspension of 40 percent chlordane wettable powder at the rate of 4 pounds in 100 gallons of water applied by soaking the plants at transplanting with ½ cupful to each plant and by dipping the roots of each plant in the suspension when transplanting. Chlordane applied by this method appeared to be as satisfactory as corrosive sublimate used in the same manner.

Observations on commercial farms indicated that chlordane dust, to be effective, must be applied when the first eggs are laid or must be washed around the roots of the plant before the maggots hatch.

Contamination of Root Vegetables by Soil Treatment with Insecticides.—Potatoes carrots, and onions grown in soil treated with chlordane, benzene hexachloride, and pure gamma isomer of BHC (Lindane) in both 1948 and 1949 were tested for taste contamination.

About twice as many tasters detected off-flavor in potatoes grown in soils treated with BHC in 1949 as in those grown in soil treated in 1948.

No taste contamination was observed in potatoes grown in soil treated in 1948 with dosages of either 2 pounds or 5 pounds actual chlordane per acre. Similar treatments in 1949 produced slight to moderate off-flavor in potatoes and in carrots. No practical taste contamination was observed in carrots grown in soil treated with chlordane in 1948. Onions, radishes, turnips, parsnips, and Swiss chard were not contaminated by any soil treatment.

The greatest off-flavor was observed in fried potatoes, considerable in boiled potatoes, and the least in baked potatoes. Pure gamma isomer of BHC at the rate of ¼ pound actual Lindane per acre caused as much off-flavor as regular BHC 12 percent gamma at the rate of 2 pounds per acre when tested both one and two years after treatment. All of the soil insecticides failed to prevent severe injury by cabbage maggot to purple top turnips grown in treated soil.

Control of Onion Thrips. (A. I. Bourne.) The protracted drought from early June throughout the rest of the growing season, coupled with continuous hot weather, furnished conditions almost ideal for thrips development. Conditions could scarcely have been more favorable for the insects had they been reared in constant-temperature tanks. Throughout the Connecticut Valley the infestation began early, built up rapidly, and by late June had reached one of the highest peaks in recent years. Many fields of set onions were heavily attacked and in

some cases seriously damaged. Many growers were forced to take measures to protect their fields. Those who had equipment for application of weed killers utilized this equipment for thrips control, with good success. Several growers used parathion, 15 percent wettable powder at 1 pound per 100 gallons, and reported excellent control, superior to results from the use of nicotine.

In field tests for control of thrips on set onions, derris, DDT, Ryanex spray concentrate, parathion (25 percent wettable powder), chlordane, and Black Leaf 40 were applied as sprays. The following dusts were also applied: 1 percent DDT dust, Isotox 10 (a 1 percent high gamma BHC dust), and a 1 percent parathion dust. Triton X-1956 was used as a wetting agent for all the sprays except Black Leaf 40, which was combined with Pine Tar soap. Following thorough application, all these materials gave practically a perfect initial kill. DDT, chlordane, and parathion, of the sprays, gave outstanding residual action, allowing little or no reinfestation during a 7-day period. Derris gave nearly as long protection, but the nicotine sulfate and Ryanex were less effective in their residual effects. Parathion and DDT dusts and the high gamma BHC dust maintained a high degree of protection for at least 7 days. The parathion spray and dust also killed crickets and other species of insects which chanced to be present in the plots at time of application.

Insecticides for the Control of the European Corn Borer. (A. I. Bourne.) Following a very mild winter with no period of very low temperature, there was little or no evidence of any winter mortality of larvae. There was a fairly heavy carry-over of larvae from a rather sizable second brood, especially in southeastern Massachusetts and in the lower Connecticut Valley.

First spring pupation was noted in early May, but light and infrequent rain, with much cold weather during the month, slowed development and 50 percent pupation was only reached the last week of May, following a 1½ inch rain.

First larval appearance was noted on June 10, in the central Connecticut Valley area. The first spray and dust application to experimental plots was made June 13. Three applications were made at 7-day intervals. There was practically no rain during the entire month of June; therefore no interference with the spray or dust program. The infestation in the experimental plots proved to be of only light to medium intensity.

Larval abundance in terms of tassel breakage was as follows: In sprayed plots, following DDT, parathion, and Ryanex, 98-99 percent of the plants were clean, and following derris, 95-96 percent of the tassels were uninfested; in the dusted plots, 97-100 percent of the plants were clean; while in the unsprayed checks, 52 percent of the tassels showed no breakage.

Yield records of harvested corn showed 98-99 percent of the corn in the sprayed plots and 97-98 percent in the dusted plots free from insect injury, compared with 73 percent of the ears in the check plots. In terms of marketable corn, 90-91 percent of the crop in treated plots was of marketable quality, while in the untreated checks only 65 percent of the total yield was of salable size and quality.

The Value of Control Measures to Supplement the Standard Spray Program for Apple Pests in Massachusetts. (A. I. Bourne, in cooperation with the Departments of Pomology and Plant Pathology.) Dormant application of DN-289 and late delayed dormant application of a tank mix Superior type oil with blood albumen emulsifier (when 2 or 3 outer leaves of blossom clusters had turned back) were made on Baldwin and McIntosh for control of aphids and red mite. On the unsprayed checks, Baldwins showed 50 aphids per 50 buds, and McIntosh 235. No living aphids were found to have hatched on trees sprayed with the

dormant dinitro and no living aphids were found on the trees given Superior oil. The red mite in this block was too light and scattering to furnish material for a real test.

Superior oil tank mix emulsion, using 1 gallon of the oil to 100 gallons of water, was applied toMcIntosh and Baldwin when the fruit buds were in the "pink" stage of development. No trace of foliage burning or distortion of the leaves was noted.

Tolerance tests of parathion (25 percent wettable powder) at one half pound per 100 gallons were made in the pink, calyx, and 1st cover sprays on Baldwin and McIntosh. Parathion was combined with Kolofog, T.A.G., and the Fermate–wettable sulfur combination. General and rather severe injury to foliage of McIntosh was noted following the pink application, especially where parathion was combined with Kolofog or the Fermate–wettable sulfur. Slightly less damage was noted following the combination with T.A.G. Very little evidence of injury could be found on Baldwins. If any occurred, it was indistinguishable from the frost injury to the foliage, which was very general on all the Baldwin trees.

In the Butcher Block, parathion (15 percent wettable powder) at 1 pound per 100 gallons, with the Fermate–wettable sulfur combination as a fungicide, was applied in calyx and 1st cover sprays to three full-grown McIntosh trees. Trees No. 1 and 2 were sprayed in the calyx; trees 2 and 3 in the 1st cover. No evidence of foliage injury was noted, either on the trees receiving a single application or on the one receiving both.

Methoxychlor (Marlate), DDT, and Rothane (DDD) were applied in a full schedule beginning with the calyx, in a test of their cooperative value against the major apple pests. All three materials were used at the rate of 2 pounds (50 percent wettable powder) plus lead arsenate 2 pounds, with the standard fungicide combination of Fermate (½ pound) and wettable sulfur (half dosage). The record of McIntosh at harvest showed both methoxychlor and DDT very effective against curculio and noticeably superior to Rothane. Curculio injury in the first two plots was held to 3.1 and 3.5 percent respectively, while 9 percent of the apples showed curculio scars following Rothane. Following methoxychlor, 1.7 percent of the fruit showed codling moth injury, with DDT holding the pest to 0.9 percent damage, and Rothane holding it to 2.6 percent injury. Against codling moth, therefore, all three materials gave excellent protection and were of approximately equal value. No leafroller or apple maggot damage was noted. Red bug damage was practically the same in all three plots and ranged from 3 to 4 percent. Advancing the application of these materials to the pink spray would undoubtedly be desirable for the control of red bugs and other plant bugs. There was practically no scab on the fruit in the entire orchard.

Potato Spraying Experiments. (A. I. Bourne.) The experimental plots were planted May 9 to the Green Mountain variety. Rainfall was somewhat light through May and growth was slowed somewhat, although progress was steady. The plots were first sprayed on June 14 when the plants were about 4 to 6 inches high. Fourteen applications were made at approximately weekly intervals up to September 15, when the plants were very well matured and very little new growth was evident. The late applications (of fungicide only) were made to protect new growtn from late blight. Bordeaux 10-5-100 was the fungicide used. DDT was added in applications June 12, 23, and 29 for first brood flea beetles and tarnished plant bugs, and in applications of July 14, 20, 27, and August 8 for second brood flea beetles.

Field counts of relative injury to foliage by flea beetles indicated the effectiveness of all forms of DDT used. Counts on June 28 of leaf perforations by first brood beetles showed 240 per leaf on foliage sprayed with Bordeaux alone, 18 per leaf following one application of a 20 percent DDT emulsion, 32 per leaf following DDT 25 percent emulsion, and 20 per leaf following DDT 50 percent wettable powder.

Samples of terminal clusters taken at the outset of the second brood flea beetles before application of DDT showed 69.3 perforations per cluster throughout the field. One application of DDT, reduced the injury to 11.8-12.0 perforations per cluster following the DDT emulsions and 7.8 perforations per cluster following DDT wettable powder.

Yield records in the various test plots still further reflected the value of DDT applications. While the crop was lighter than normal as a result of the drought throughout the entire summer, yields were consistently higher where 25 percent DDT emulsion or DDT wettable powder was applied than following the use of Bordeaux alone.

Field tests on a farm in Hadley against a very heavy outbreak of potato aphids showed that neither DDT emulsion nor nicotine sulfate gave an immediate kill high enough to prevent serious damage. Application of 15 percent parathion at 1 pound per 100 gallons or TEPP at one fourth pint per 100 gallons gave very speedy and almost complete kill; in fact, practically eliminated the aphids.

Biology and Control of the Celery Plant Bug. (W. D. Whitcomb, W. J. Garland and C. S. Hood, Waltham.) In 1949, the first celery plant bugs were found in the experimental plantings on June 24, when 10 to 30 percent of the plants were lightly infested. The plant bug continued to be present in small numbers only, and damage to untreated plants did not become serious. Under these conditions all insecticides gave practical control, the most satisfactory being DDT and parathion as sprays and rotenone-pyrethrins plus a synergist as dusts.

Analyses again showed excessive residue of DDT on leaves 27 and 28 days after application even though about 2 inches of water was applied by sprinkler during the period. This ranged from 12 to 14 p.p.m. where 50 percent DDT at the rate of 1 pound per 100 gallons was applied, to 22.7 p.p.m. where a 3 percent dust was used. Because of the general use of celery leaves for seasoning and garnishing, other effective materials must be used in place of DDT.

Control of Plum Curculio in Apples. (W. D. Whitcomb, W. J. Garland, and C. S. Hood, Waltham.) In 1949, continued high temperatures during the active period of the plum curculio concentrated the attack of this pest and favored good control where timely sprays were applied. Winter survival of the beetle was high, and there was a large population throughout the State.

In the experimental orchard a block of trees which received an ineffective treatment too late had 66.79 percent of the fruit damaged and 74.47 percent fell before it matured.

The outstanding insecticide used in these experiments was methoxychlor, an analog of DDT. When used alone as a 50 percent wettable powder at the rate of 3 pounds per 100 gallons of water, or at the rate of 2 pounds combined with 2 pounds of lead arsenate per 100 gallons, it produced 98 + percent uninjured fruit. The combination of 50 percent DDT powder 2 pounds plus lead arsenate 2 pounds per 100 gallons of water also gave 98 percent protection, and again justified its recommendation in the apple spray schedules. A new compound, Aldrin, gave good control of the curculio at 3 pounds of 25 percent powder in 100 gallons, but failed to protect against codling moth and red-banded leafroller.

Other treatments when used at the following amounts in 100 gallons of spray

were slightly less effective: 50 percent chlordane wettable powder 3 pounds; lead arsenate 2 pounds plus 50 percent DDD (Rothane) wettable powder 2 pounds; 50 percent chlordane wettable powder 2 pounds plus 50 percent DDT powder 2 pounds; 25 percent parathion ¾ pound and 15 percent parathion (safened) 1½ pounds. Parathion in each form caused injury to leaves and fruit.

Results of these studies were reported and published in the Annual Reports of the Massachusetts Fruit Growers Association, the Maine Pomological Society, and the New York State Horticultural Society.

Apple Maggot Emergence. (W. D. Whitcomb, Waltham.) The number of apple maggot flies which emerged from the hibernation cages at Waltham in 1949 was the smallest recorded in the past twenty-five years, being only 10 percent of the expected number. This small emergence was apparently due to the drought and lack of sufficient moisture in the soil to enable the insects to pupate and emerge as flies.

The first fly was collected June 22 but 25 percent of them did not emerge until July 11. The greatest number appeared July 16 to 19, and the last on August 5. By digging up the insects in late August after natural emergence was completed, it was found that approximately 5 percent of the pupae were alive and were prepared to emerge in 1950.

Emergence cages placed under sprayed apple trees showed that many of the flies were killed by the spray residue as they emerged from the soil. The results in 1949 were:

Sprayed Trees *Material and Amount in* 100 *Gal.*	*Percent Flies Dead* 24 *Hours After Emerging*
1—Lead Arsenate, 2 lb. + 50 DDT 2 lb.	66.7
2—15 Parathion, 1½ lb.	32.8
3—50 Methoxychlor, 3 lb.	66.7
4—25 Aldrin, 3 lb.	25.0

Biology and Control of Grape Cane Girdler. (W. D. Whitcomb and C. S. Hood, Waltham.) Activity of the grape cane girdler in 1949 was concentrated because of high temperatures into the period from May 15 to June 15. Control by spraying was effective for 5 to 7 days while the new canes were growing 12 to 15 inches. During the first part of the active period when the beetles were moving into the vines from hibernation, spraying reduced the number of girdled canes 80 to 95 percent. The most effective formulas were: lead arsenate 2 pounds plus 50 percent DDT 2 pounds, and 25 percent parathion 1 pound, per 100 gallons of water. A dust containing Lindane, DDT, and sulfur was effective for 7 days or until washed off by rain.

Chlordane 50 percent wettable powder at the rate of 4 pounds per 100 gallons of water caused severe foliage injury and its use was abandoned after one application.

In all experiments, spraying prevented significant injury to the vines or grapes.

Biology and Control of Common Red Spider on Greenhouse Plants. (W. D. Whitcomb, W. J. Garland and C. S. Hood, Waltham., New miticides were evaluated for the control of the common red spider on greenhouse roses as follows:

Gearphos (Geary Chem.) — dialkyl nitro aryl thiophosphate
Arathane (Rohm & Haas) — dinitro capryl phenyl crotonate
C 854 (Dow) — p-chlorophenyl benzene sulfonate

When these miticides were diluted according to the manufacturers' directions and applied as sprays four times at weekly intervals, all formulations gave excel-

lent protection. Residual action of these miticides following one application was good for two weeks but unsatisfactory for longer periods.

Study of Euonymus Scale and Its Control. (W. D. Whitcomb and W. W. Cantelo, Waltham, in cooperation with the Bartlett Tree Expert Company.) Further studies of the seasonal history of the Euonymus scale showed that the high temperatures in June and July, 1949, enabled this insect to complete its development in 49 days, compared to 63 days in the cooler weather in 1948. In constant-temperature cabinets, the life cycle varied from 40 days at 80° F. to 68 days at 60° F. The maximum number of eggs per female scale was 81 and the greatest number was laid August 24. Crawlers traveled as far as 16 inches and nearly always moved upward. In a natural population there are about five times as many male scales as female, and there are five times as many scales on the leaves as on the stems.

As a dormant spray, regular oil emulsion diluted to 4 percent and Superior oil emulsion at 2 percent gave satisfactory control without injury to the plants. Greater dilutions were not effective from a practical standpoint. Evaluation studies on the crawlers of the summer generation of the scale showed that DDT was more effective than its analogs, DDD, DFDT, or methoxychlor. Effective control of the crawlers in June and August was obtained with the combination of oil emulsion (Volck) 2-100 plus 40 percent nicotine sulfate 1-800, and with 25 percent DDT emulsion (Resitox 25) 1-200. Both of these treatments killed newly settled scales ten days old or less, and the residue prevented crawlers from settling for ten days after application. In this way, one treatment gave protection for about three weeks.

Materials and Methods Which Promise Value in Control of Insect Pests of Ornamental Shrubs, Shade and Forest Trees, and Forest Products. (W. B. Becker.)

Insect Control Tests.—(With Hydraulic Sprayers.)

Beech aphids: Excellent control was obtained with a 25 percent parathion wettable powder (1 pound per 100 gallons) on cut-leaf and copper beeches.

Butternut lace bugs: Promising control was obtained with a 35 percent tetra ethyl pyrophosphate emulsion (1-2400 by volume); poor control, with a 50 percent DDT wettable powder (2 pounds per 100 gallons).

Imported willow leaf beetle: Promising control was obtained with a 50 percent methoxychlor and also with a 50 percent benzene hexachloride wettable powder (2 pounds per 100 gallons).

Fall webworm: Promising control was obtained with a 25 percent (gamma isomer) benzene hexachloride emulsion (1-800 by volume); excellent control, with a 50 percent methoxychlor wettable powder (2 pounds per 100 gallons).

No plant injury resulted from any of these spray applications.

(With Mist Blowers)—Fall webworm: Excellent control was had with a 50 percent methoxychlor emulsion applied lightly.

(With Small Compressed Air Sprayers)—In preliminary tests in which white pine logs of cord-wood size were thoroughly wetted on all surfaces, excellent prevention of infestation by sawyers, flat headed borers, bark weevils, and ambrosia and bark beetles resulted all season long from single applications of ½ and 1 percent (gamma isomer) benzene hexachloride emulsions and oil solutions. Results with 1 and 2 percent DDT emulsions and oil solutions were erratic, ranging from poor to fair.

Spray Injury Tests.—(With Hydraulic Sprayers)—The following insecticides caused no injury to many different broad-leaved deciduous or needle-leaved plants sprayed at the indicated concentrations and weather conditions.

Dormant Applications: Shell's Helix Superior Oil No. 22 for tank mix (2-100 by volume) plus ½ pound blood albumen: air temperature 42°-45° F., humidity 30-38 percent; Pratt's Scalecide (1-25): air temperature 51°-57° F., humidity 23-26 percent; Sunoco Spray Oil (1-30): air temperature 57°-58° F., humidity 26-23 percent.

Early June Applications: Du Pont's 50 percent methoxychlor wettable powder (Marlate 50) (2 pounds per 100 gallons): air temperature 53° F., sunny and windy; Du Pont's 50 percent benzene hexachloride wettable powder (Lexone 50) (2 pounds per 100 gallons): air temperature 53°-60° F., humidity 48 percent; American Cyanamid's 25 percent parathion wettable powder (Thiophos 3422) (1 pound per 100 gallons): air temperature 60°-62° F., humidity 48-45 percent.

Late July and Early August Applications: Niagara's 35 percent tetraethylpyrophosphate emulsion (Hexide 200) (1-2400): air temperature 83° F., humidity 52 percent (test limited to cut-leaf and copper beeches) Niagara's 25 percent (gamma isomer) benzene hexachloride emulsion (Gam-Kil 25) (1-800): air temperature 77°-89°F., humidity 71-49 percent.

Some degree of plant injury resulted from applications of the following materials at the given weather conditions.

June Applications: Shell's Helix Superior Oil No 22 for tank mix 1-100 by volume) plus ½ pound blood albumen: air temperature 84° F., humidity 56 percent. Of many kinds of trees sprayed with this oil, sugar maple and cherry trees sometimes, but not always, showed spray injury. Dow's dinitro-ortho-cyclohexyl-phenol (DN-111) (1¼ pounds per 100 gallons): air temperature 66°-70° F., humidity 48 percent. Once again this material injured many kinds of broad-leaved deciduous shade trees but did not harm any needle-leaved plants.

Sprays to Prevent Scolytid Infestation of Elm Logs. (W. B. Becker.) In small-scale tests, single applications of 1 percent DDT, methoxychlor, Toxaphene, chlordane, and benzene hexachloride (gamma isomer) spray emulsions all gave excellent protection all season long against infestation by elm bark beetles. *Scolytus multistriatus* Marsham outnumbered *Hylurgopinus rufipes* (Eich.) in the unsprayed checks by over two to one.

Sprays to Kill Scolytids Breeding in Elm Logs. (W. B. Becker.) In small-scale tests, elm logs that were infested with elm bark beetles were sprayed approximately two weeds before beetles emergence. One percent DDT, chlordane, and Toxaphene, and 0.2 to 1.0 percent (gamma isomer) benzene hexachloride showed much promise in preventing beetle emergence or killing those beetles which did emerge before they could breed in freshly cut unsprayed elm logs which were available to them. A 1 percent methoxychlor emulsion spray gave poor results in this test.

Spraying to Prevent Twig Feeding by the Smaller European Elm Bark Beetle. (W. B. Becker.) Methoxychlor emulsions (1 and 2 percent, especially the latter) gave good, long-lasting protection against twig feeding, approximately equivalent to that obtained with DDT emulsions of equal concentrations. Low branches were sprayed at close range with small compressed air sprayers, and tall trees were sprayed with a large power sprayer. In tall trees, twig samples were collected at different heights for beetle feeding tests (the same as described in Mass. Agr. Expt. Sta. Bul. 441:41-42, 1947).

Spraying Tests with DDT for Dutch Elm Disease Control. (W. B. Becker.) The site chosen for this test was one where elm logs had been piled and left untreated over a period of many years, where elm bark beetles bred in large numbers,

and where Dutch elm disease had been killing surrounding elms at a particularly rapid rate. One group of elms was sprayed with large amounts of DDT by a mist blower (2 to 5 pounds DDT technical per tree, depending upon its size). A second lot of elms was sprayed lightly by the municipality, reportedly two to four times a year (perhaps about 1/16 of a pound of DDT technical per tree at each application). A third group of trees in a ravine could not be reached with the spraying equipment and was used as an unsprayed check. At the end of the first season, not one of the sprayed or unsprayed elms in the test showed any symptoms of Dutch elm disease. It is suspected that the municipality's newly instituted Dutch elm disease sanitation program in the vicinity influenced the results. It is hoped that this spraying test will continue for several years and that additional tests can be started at other places.

FEED AND FERTILIZER CONTROL SERVICES
John W. Kuzmeski in Charge

The feed, fertilizer, and milk testing laws are administered as one service and the operations of each, with the exception of the milk testing law, are reported in annual bulletins.

Under the milk testing law 4,652 pieces of Babcock glassware were calibrated and 205 certificates of proficiency in testing were issued. All milk depots and milk inspection laboratories in the Commonwealth were visited at least once to check apparatus and general conduct of the work.

In addition to the regulatory work, the Feed and Fertilizer Control laboratories have examined feeds, fertilizers, and other agricultural materials for citizens of the Commonwealth without charge whenever the results were considered of interest to the general public or to the Control Services.

Considerable work has been done on research projects in cooperation with other departments of the University and Experiment Station. The results of such work are reported by the departments originating the projects.

DEPARTMENT OF FLORICULTURE
Clark L. Thayer in Charge

The Effect of Soluble Salts on Florists' Crops. (Harold E. White.) Fertilizer materials were applied to carnation plants at three different levels, as follows: Series A: Ammonium sulfate 1.50, nitrate of soda 2.25, and muriate of potash 0.25 pounds per 100 square feet bench area. Series B: Ammonium sulfate 2.50, nitrate of soda 3.25, and muriate of potash 0.75 pounds. Series C: Ammonium sulfate 4.00, nitrate of soda 5.0, and muriate of potash 1.0 pound. The fertilizers were applied in four doses one to each plot in September, October, November, and March. Plot treatments were replicated three times with 56 plants per plot, and included four varieties of carnations.

The soluble salts increased in the soil from 34 x 10^{-5} mhos to 46 x 10^{-5} mhos for Series A, 55 x 10^{-5} mhos for Series B, and 86 x 10^{-5} mhos for Series C. The plants showed no unfavorable effects from any of the fertilizer treatments. The number of flowers produced was 723 in Series A, 741 in Series B, and 753 in Series C. No difference was noted in the quality or grades of flowers produced, and the splitting of the blooms did not vary.

Snapdragon plants treated in the same manner as carnations showed no symptoms of plant injury but did show a decrease in flower production at the highest fertilizer level. Flower production for the season was 858 blooms for Series A,

827 for Series B, and 661 for Series C. The quality and grades of blooms were not significantly affected by the treatments.

Soluble salt readings were much higher for the snapdragon soils than for the carnation soils. Solu-bridge soluble salt readings increased from 35 x 10^{-5} mhos to 100 x 10^{-5} mhos for Series A, 110 x 10^{-5} mhos for Series B, and 130 x 10^{-5} mhos for Series C. These data show that high soluble salt accumulation from fertilizers in soil will affect flower production of snapdragons, even though there may be no visible plant symptoms of injury from the salts.

The Effect of Soil Temperature on Flowering of Carnations. (Harold E. White) Carnation plants were grown in heated soil, maintained at a temperature of 60°-62° F. from September through April, in comparison with unheated greenhouse soil which had a temperature of about 50°-52°. Soil temperature in the heated plot was controlled by a lead-covered electric heating cable buried in the soil and regulated by a thermostat. Temperature records of the soil were kept by a recording clock thermometer. Sixteen different varieties of carnations were used in the test, with 252 plants each in heated and unheated soil.

No significant differences were observed in growth or flowering of the plants, in quality of the blooms, or in splitting of calyxes of the flowers in heated and unheated soils. During the season 1561 blooms were produced in the unheated soil plot as compared to 1577 blooms in the heated plot.

Chemical Treatment of Soils for Control of Root Nematode. (Harold E. White.) Preliminary studies with Begonias in nematode-infested soils treated with benzene hexachloride or chlordane emulsion indicate that these chemicals are worthy of further investigation for control of root nematodes.

Nematode-infested soils from the greenhouse were treated with a wettable powder containing benzene hexachloride 12 percent gamma isomer at rate of 10, 15, 20, and 25 grams per 6-inch Azalea pot of soil. The powder was thoroughly mixed with the soil which was then kept well watered for a period of two weeks. In another series, pots of soils were treated with solutions of chlordane emulsion 20 percent at dosage rates of 10, 20, 30, and 50 cubic centimeters per pot. Nematode-infested soils heat-treated at 180°-200°F. and untreated soils were used as check treatments. A period of two weeks was allowed to elapse before seedling Begonias were transplanted to the differently treated soils. At the end of two months the plants were carefully removed from the pots and the roots washed free of soil with water.

Top growth of the plants was retarded and roots of the plants showed varied degrees of injury at all concentrations used in the treatments with benzene hexachloride and chlordane. This effect on plant growth was more noticeable with chlordane than with benzene hexachloride and in both cases was more severe as the dosage was increased. With benzene hexachloride the 10 and 15 gram treatments did not injure the plant roots or retard top growth too severely.

No nematode galls were found on the plants treated with the two chemicals or on roots of plants in the heat-treated soil, but plants in untreated soils were heavily infested with nematode galls.

Roots containing nematode galls were mixed into the soils before treatment with the chemicals, and on examination at the end of the experiment were found to have been well decomposed in comparison with infested roots in the untreated soil.

Whether nematode-infested soils can be treated successfully with benzene hexachloride or chlorodane within limits of toxic effect to the plants would have to be further determined.

The Effect of Nutrient Elements and Light on Carnations. (N. W. Butterfield, F. J. Campbell, Waltham.) The experiments on nutrients were a failure because of the severe loss of plants by bacterial wilt in most of the plots. With the remaining plots particularly high in potassium, there was a queer mottling in the leaves. It is possible that the high potassium was causing a deficiency of magnesium. More studies are being carried out on this phase of the problem this year.

During the past year samples of soil were collected each month on three varieties—Northland, William Sim, and Virginia—from fifteen growers. Records were kept of production and amounts of fertilizer used. Data for the year are not complete but there are a few points of interest at this time. The soils were tested monthly for soluble salts, pH, N, P, K, and Ca, and in the soils of some growers soluble salts were found to be above the maximum range of 100 (International system). The growers were notified of this condition, and those who leached their soils reported tremendous increases in growth.

The analyses of calcium and potash were run on the flame photometer at the Experiment Station at Amherst. The lowest calcium level reported was 750 p.p.m. and the highest 4,000 p.p.m. It is believed that the range for optimum growth should be at 2000-2500 p.p.m. The potash ran from 40 to 600 p.p.m. It is believed that the optimum should be from 200 to 300 p.p.m. Much will depend on the nitrate level and the age of the plants.

The tests for nitrate and phosphorus were run colorimetrically on the new Fisher nefluorophotometer. This instrument proved an accurate and rapid means for determination of these two elements.

Gypsum versus Lime For Florists' Crops. Of special interest to growers were the preliminary results of an experiment on the use of gypsum to correct the low calcium when high pH prevails in the soil.

In the past, a grower hesitated to add lime if the pH was above 6.5 and the soil had a low calcium condition. During the past year gypsum has been recommended when this condition existed. As a result of preliminary work it was found that two applications of gypsum ($CaSO_4$) increased the soluble salts nearly twice over what they were in the check. This is not a serious problem, for sulfates leach out rather readily, this treatment being advised when the tests showed high soluble salts.

The normal soil (check) had 1500 p.p.m. of calcium. When two applications each of 3 pounds of ground limestone to 100 square feet were added, the calcium was increased to 1800 p.p.m. When two applications each of 3 pounds of gypsum were added, the calcium was increased to 2400 p.p.m. The tests were made on the flame photometer at the Experiment Station at Amherst.

The soil for the check plot had a pH reaction of 5.5 At the end of the year the soil receiving the ground limestone had a pH of 6.3, and the soil receiving the gypsum 5.05 pH. This showed that gypsum had a depressing effect on the pH. The calcium was taken up by the plants, leaving the sulfate radical to combine with the hydrogen to increase the acidity.

The Effect of Mulches on Carnations. (F. J. Campbell, Waltham.) Four mulches—corn cobs, peanut shells, sawdust, and manure—were applied to two varieties of carnations. The treatments were randomized in three different benches with a check plot in each bench. The object of this experiment was to study the effect of mulches on pH, production, general vigor, disease, and on nutrients and the soluble salt conditions throughout the year.

The pH was lower for all mulched plots than for the check; and, more specifically, the pH of the manure plots was lower than the pH of the sawdust, corncob, or peanut-shell plots.

Some mulches had a tendency to increase the soluble salts of the soil. This was particularly true of manure. At the end of the season the soluble salt content of the manure plots was nearly double that of the other mulched plots.

Some mulches have the tendency to increase soil friability or porosity. The plots mulched with corn cobs seemed to have the greatest increase in porosity. To a lesser degree, sawdust was next and then peanut shells in order of degree of porosity.

There seemed to be no significant difference in production for the different mulches, and all plots, including the check, seemed to require the same amount of water for optimum growth. It is generally believed that mulches help to conserve water, but this did not prove to be true in this experiment.

Some growers hesitate to mulch carnations for fear that stem diseases will be increased. The losses were extremely low in all these treatments. However, the plants were set particularly high.

The Effect of Chemicals on Carnation Pathogens. (N. W. Butterfield, Waltham.) During the past few years carnation growers in this area have experienced heavy losses of young plants, and efforts to control diseases have failed. It was hoped that some of the new chemicals would be effective, especially in controlling surface-borne diseases such as Rhizoctonia.

Six chemical treatments, consisting of Fermate, Phygon XL, Fulex A, Fulex B, and Fulex A and B, and a check were used in the experiment. Cuttings of the variety Northland were obtained from a reliable grower and treated with the chemicals except Fulex A, which was known to be injurious to cuttings. Cuttings rooted well with all treatments.

The young rooted cuttings were treated immediately after being planted in Vita bands and received four additional treatments in the bands. The six treatments were partially randomized in six different benches, and on July 21, 1949, the young cuttings were planted in the benches and immediately treated. They received three additional treatments in the benches before cool nights came in September.

The results this year were negative. There was considerable variation between the same treatment in the different benches. For example, losses in one bench for the check were 3 percent, whereas in another the losses were 55.1 percent. The differences in losses for the same treatment in different benches were less with Fermate and Phygon XL.

There was no consistent indication that chemical soil treatment arrested or controlled the fungus *Rhizoctonia*. On the basis of this year's results, growers are strongly urged not to purchase expensive chemicals for controlling carnation pathogens. Better cultural practices, such as sterilization of propagating medium, better selection of cuttings, and sterilization of old soils are being stressed.

Effect of Light on Prolonged Chrysanthemum Bloom and Change of Flowering Habit. (N. W. Butterfield, Waltham.) Some varieties of chrysanthemums have a tendency to produce very tight clusters of flowers, a condition that retailers do not like for their design work. With some varieties, this condition may be changed by variations of long and short day treatment.

The varieties Gold Coast, Yellow Fellow, Masterpiece, Bittersweet, and Early Godfrey were obtained from a grower and planted July 2, 1949. Each variety received the following treatment: (1) Check or normal light; (2) Plants shaded from 5 p.m. to 8 a.m. August 12 to October 6; (3) Plants shaded between 5 p.m. and 8 p.m. August 12 to 19 and lighted to 10:30 p.m. from August 19 to September 15; (4) Plants lighted to 10:30 p.m. from August 12 to September 15, followed by normal light to flowering.

Gold Coast, Masterpiece, and Bittersweet had longer laterals and more flowers per spray from treatment 3. Yellow Fellow and Early Godfrey showed no response to this treatment. Therefore, it will be necessary to experiment with each variety showing a different type of inflorescence.

Tulip Trials. (F. J. Campbell, Waltham.) During the fall of 1949, approximately 16,000 tulip bulbs representing ninety-six varieties were planted in eighteen beds.

In each of nine beds the following six varieties were planted: Dido, Princess Elizabeth, Blue Perfection, Glacier, Mrs. John T. Sheepers, and Eclipse. Three planting depths,[1] 6, 8, and 10 inches, were triplicated, and two treatments for fire blight were employed. Each planting depth included a check, a treatment with Parzate, and a treatment with Fermate. The chemicals were dusted on the bulbs immediately before planting. In the spring season of 1950 there was little or no difference between the 6 and 8 inch depth of planting. However, the emergence, date of bloom, and height of the bulbs in the 10 inch bed were greatly retarded.

The remaining nine beds were employed as a varietal trial for tulips grown under New England conditions. Here, the planting depth for ninety varieties averaged 6 inches. Darwin, Cottage, Breeder, Double, and Parrot tulips were represented.

A few sections of the varietal trials were sprayed with 2, 4-D, applied to one-half of each variety after the tulips had finished blooming. An inactivator was applied three hours after the 2, 4-D treatment.

It is planned to let the bulbs remain in the ground for at least two years in order to determine whether the treatments for fire blight and the 2, 4-D treatments are beneficial or detrimental, and to determine the degree of vigor of each variety.

DEPARTMENT OF FOOD TECHNOLOGY
C. R. Fellers in Charge

Processing Methods for Pasteurized Fresh Cucumber Pickles. (W. B. Esselen, Jr., E. E. Anderson, L. F. Ruder, E. A. Nebesky, and N. Glazier,) This investigation was initiated to study the degree of pasteurization or heat treatment required to prevent spoilage of pasteurized fresh cucumber pickles. A large volume of these pickles is packed at present. The general procedure consists of packing washed raw cucumbers into jars, adding a low-acid, low-salt brine with appropriate flavoring agents, sealing, and pasteurizing the jars at temperatures ranging from 165° to 190°F. From time to time spoilage has been encountered with this product. Upon its completion this study should provide further information on factors which influence the process requirements of this type of pickle as well as additional heat penetration and microbiological data to serve as a guide in formulating adequate pasteurization procedures.

During the 1949 season tests were made on 11 experimental packs of fresh cucumber pickles put up in the laboratory as well as 9 packs put up under commercial conditions in three different pickle plants located in this area. Additional heat-penetration tests were made on gallon jars of pickles and on quart jars at various processing temperatures. These packs of pickles had an equalized acidity of from 0.4 to 0.6 percent acetic acid.

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[1] Depth of planting is the distance from the top of the bulb to the surface of the soil.

Process Time Requirements.—Two characteristic types of spoilage have been observed. In most cases spoilage that occurred within three weeks of packing was characterized by vigorous gas production and cloudiness. Much of the spoilage that developed after three weeks was characterized by the formation of a white sediment in the bottom of the jar and occasional clouding of the brine. Jars of pickles showing this type of spoilage have been found from time to time on store shelves. The data obtained from the experimental packs indicate that a process equivalent in severity to at least 0.2 minutes actual holding time at 212° F. is necessary to prevent spoilage. When the pasteurization is done at 180° to 185° F. it would appear that these requirements will be met if a brine temperature of 175° to 180° F. is reached in the lower central part of the jar.

Destruction of Enzymes.—The available data indicate that the enzyme peroxidase in fresh pickles is more heat-resistant than spoilage organisms which are encountered. Preliminary tests have indicated that the thermal destruction of the enzyme indophenol oxidase may more closely parallel the destruction of spoilage organisms than does the destruction of peroxidase.

Development of Off-Flavor.—Observations on the experimental packs of pickles, after seven months storage, indicated that off- or stale flavors developed in pickles given the shorter process times. The process times necessary to prevent the development of these off-flavors tended to approximate the process times required to prevent microbial spoilage in some cases; however, the results were somewhat erratic. The off-flavors encountered resembled those observed in pickles to which a peroxidase enzyme preparation was added or the off- or hay-like flavor that develops in inadequately blanched dehydrated and frozen vegetables. Therefore, it is suspected that this off-flavor in pickles may be caused by enzymes which were not destroyed during the process.

Bacteriological Findings.—Limited observations on the washing procedures employed in commercial pickle plants have shown that, while these procedures are effective in removing physical dirt such as soil and sand, they are not effective from a bacteriological standpoint. Rather than reducing the bacteria load, such washing and soaking methods tend to recontaminate and increase the bacteria load in pickles. The practical significance of this factor in relation to processing requirements remains to be determined.

As has been found by other investigators, the processing treatments given fresh cucumber pickles do not completely sterilize the jar contents. In the above tests it was found that after a process of 15 to 25 minutes at 180° F. the bacteria count was reduced to about 20 to 300 organisms per milliliter of brine in the jars. This appeared to be a residual level which was not significantly reduced by longer process times up to 40 minutes. These residual levels of bacteria counts did not change significantly during storage of the pickles for seven months.

The addition of 20 p.p.m. of mustard oil (allyl isothiocyanate) did not have a significant effect on the process requirements of fresh cucumber pickles.

Heat Resistance of Microorganisms Isolated from Jars of Spoiled Pickles.—Preliminary tests indicate that the more heat-resistant spoilage organisms isolated from pickles have a heat resistance approximating 0.2 minutes at 212° F. This is in good agreement with the observed process requirements of the pickles based on heat penetration and spoilage tests.

Studies on the Peroxidase in Acid Foods. (W. B. Esselen, Jr., E. A. Nebesky, and C. R. Fellers.)

Effect of Peroxidase on the Quality of Processed Cucumber Pure. —Studies to determine the effect of various concentrations of peroxidase on the quality of

processed packs of purèd cucumber pickles stored at various temperatures have been extended. The presence of peroxidase was found to play a role in lowering the quality of the color, flavor, and aroma of processed cucumbers. The effect on quality was recognized by the development of a distinct flat or haylike flavor and aroma along with a bleaching or fading of color. This deterioration was more noticeable with samples containing the greater concentration of peroxidase, and with samples stored at the lower temperature, 35° F., than with similar packs stored for the same period at 100° F.

Although the peroxidase extract obtained in this investigation exhibited strong peroxidase activity, other enzyme systems such as polyphenolase, catalase, phosphatase, ascorbase, and pectinase, which are known to occur in the raw material, were undoubtedly present. Therefore, the deterioration in the processed packs may have been due to the cumulative effect of peroxidase and other respiratory enzymes. However, the high thermostability of peroxidase in comparison with other enzymes suggests the possibility that this enzyme alone may survive the heat treatment and be responsible for deterioration in processed foods.

Effect of Maturity on Peroxidase Activity.—Subsequent studies have revealed that the concentration or distribution of peroxidase varied in different lots of the same products. A study was initiated to determine the relationship between maturity and peroxidase activity of fresh pears. The degree of peroxidase activity was determined in representative samples of the fresh fruit and at various stages of maturity from the very green (immature) to ripe, over-ripe, and decayed (excessively over-mature) stages. Investigiatons were also made to determine the relationship between degree of maturity and peroxidase activity in samples during storage at 70° to 80°F. and 35°F. The peroxidase activity in fresh pears as measured during various stages of maturity varied considerably. The activity was greatest when the pears were very green and decreased only slightly up to the ripe stage but decreased markedly from the ripe to over-ripe and excessively over-ripe stages. The results obtained from determinations of peroxidase activity of fresh pears allowed to ripen during storage at 70° to 80°F. and 35°F. showed that with samples stored at the higher temperature the variation in peroxidase activity during ripening was more significant than with samples stored at 35°F., because of the increased rate of maturation at the higher temperature. In the former case the fruit matured from the very green to the excessively over-ripe stages within a period of 12 days, while in the latter it required six weeks for the fruit to ripen from the very green to the over-ripe stages. Maturity of the pears was determined by visual and organoleptic examination as to color, firmness of texture, and taste. The data obtained are of interest since earlier studies revealed that the thermal destruction time for the peroxidase of various foods increased with increased concentration of the enzyme.

Peroxidase Activity in Commercially Packed Foods.—This study was concerned primarily with determining the extent of peroxidase activity in a number of commercially packed acid foods to ascertain whether the processing conditions for these products were sufficient to insure destruction or inhibition of the enzyme systems. A variety of canned fruits (apples, apricots, peaches, pears, fruit cocktail) and a number of cucumber pickle products (Kosher style dill, processed dill, sweet mixed, mustard, chow chow, candied sticks, picklesticks, and piccalilli) obtained from the shelves of local markets and representing a number of manufacturers were investigated. The commercial processing conditions of time and temperature as used for the destruction or inhibition of microorganisms capable of producing deterioration were also sufficient to insure the complete inactivation of the peroxidase system in these foods with the exception of packs of Kosher

style dill and processed dill pickles. The peroxidase was observed to be highly active in representative samples obtained from the former and moderately active in samples obtained from the latter.

Preservatives for Fresh Cider. (W. B. Esselen, Jr., and E. E. Anderson.) Experiments were carried out to observe the comparative preservative action of mustard oil (allyl isothiocyanate), sodium benzoate, and sulfur dioxide as preservatives for fresh cider. Freshly expressed McIntosh cider was used. Sulfur dioxide, added in the form of sodium bisulfite, was unsatisfactory as a preservative for fresh cider. In the concentrations used, 200, 500, 750, and 1000 p.p.m. sulfur dioxide, a strong sulfur dioxide flavor was imparted to the cider. Fermentation was prevented by 500 p.p.m., but not by 200 p.p.m. sulfur dioxide. A characteristic flavor could be detected in the cider when concentrations of .08 percent or greater of sodium benzoate or 20 p.p.m. of mustard oil were added. Concentrations of .04 to .06 percent sodium benzoate with 5 to 10 p.p.m. of mustard oil appeared to provide good preservative action without imparting off-flavors to the cider.

Processing Studies on Home-Canned Asparagus and Beets in Quart Jars. (Cooperative Project with Bureau of Human Nutrition and Home Economics, U. S. Department of Agriculture.) (W. B. Esselen, Jr., W. Averill, and J. Licciardello.) Heat-penetration data were obtained on asparagus cuts and spears, and beets (small whole, quartered, sliced, and diced) in quart jars processed in a pressure canner at 240°F. (10 pounds steam pressure). Overfilling, to the extent that might be encountered in normal home canning practice did not significantly affect the rate of heat penetration in home canned beets. The data obtained indicate that process times of 40 minutes at 240°F. for asparagus cuts and spears and small whole, quartered, and diced beets and 45 minutes for sliced beets in quart jars should be adequate for these products.

An Experiment Station Bulletin (No. 456) on the processing requirements of home canned baked beans, hominy, and white potatoes, based on work carried on during the past three years, has been prepared.

Fruit Pie Fillings. (E. E. Anderson, R. Nielson, and W. B. Esselen, Jr.) The preparation of complete, ready-to-use apple, blueberry, cherry, and peach pie fillings has been investigated. The preparation of such products involves the incorporation of sugar and a suitable thickening agent with the fruit. To date a number of starches and gums have been compared for use as thickening agents. Cornstarch and modified cornstarch in amounts of 1.0 to 2.0 percent were the most satisfactory of the thickening agents studied so far. When starch is used as a thickener in frozen fruit pie fillings it shows marked retrogressive changes on freezing and thawing. However, it performs its function as a thickening agent when the pies are baked.

Utilization of Mahogany Quahogs. (C. R. Fellers.) Experimental work has been done on the utilization of mahogany or ocean quahogs. Rich sources of this quahog have recently been located off the New England Coast. A very satisfactory canned chowder can be made from this quahog. This is a totally undeveloped resource of the State.

Freezing Cultivated Blueberries. (W. B. Esselen, Jr. in cooperation with J. S. Bailey, Pomology Department.) From time to time complaints have been received that the skins of frozen blueberries may be tough. In variety tests with cultivated blueberries during the 1948 season it was observed that some varieties had tough skins after freezing and storage. In 1949 tests were conducted in an

effort to determine the cause of tough skins on frozen cultivated blueberries. Of the 10 varieties tested some had tough skins and others did not. Varieties which had tough skins in 1948 were not necessarily tough in 1949. Stage of maturity and exposure to bright sunlight after picking did not appear to be related to tough skins. There are reports in the literature that blanching will prevent toughness in blueberry skins by inactivating the enzymes responsible for this change In 1949 the 10 varieties tested were frozen both blanched and unblanched. In no case did blanching prevent tough skins. Thus, to date, no satisfactory answer is forthcoming as to the cause and control of tough skins in frozen blueberries.

Use of Home Canning Jars as Containers for Home Freezing. (W. B. Esselen, Jr., and M. D. Labbee.) Various types of home canning jars have been studied from the standpoint of their suitability as containers for home and locker frozen foods. Freezing rates of glass, tin, and paper containers, of pint size, packed with 10 percent sugar syrup were determined and were found to be similar for all practical purposes. Dry-packed vegetables, meats, and dry and syrup-packed fruits and fruit juices can be frozen successfully in home canning jars without danger of breakage of the container provided adequate headspace is allowed for expansion of syrup-packed products and fruit juices during freezing. Breakage was encountered with brine-packed vegetables. Both round and square pint and quart home canning jars with different types of closures were employed in these tests. From the standpoint of convenience of use and ease of stacking, the two-piece metal lid appeared to be very satisfactory for home freezing. A survey made within the State indicated that people are using home canning jars with apparent success for home freezing.

Further Aspects of Trimethylamine Formation in Fish. (D. W. Anderson, Jr., and C. R. Fellers.) Small-mouthed black bass (*Micropterus dolomieu*), pickerel (*Esox niger*), white perch (*Morone americana*) yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigro-maculatus*), sunfish (*Lepomis gibbosus*), eastern golden shiners (*Notemigonus crysoleucas*), and bullheads (*Ameiurus* sp.) were analyzed for trimethylamine and trimethylamine oxide, and all were found to contain small amounts of trimethylamine. The small-mouthed bass, pickerel, white perch, black crappie, sunfish and blue gill were found to contain trimethylamine oxide.

The trimethylamine oxide content of hatchery brown trout (*Salmo trutta fario*) fed a diet containing trimethylamine oxide (from herring) was found to be cumulative, and appeared to be of exogenous origin. On the other hand, the origin of trimethylamine oxide in fresh water fish from a local lake appeared to be of endogenous origin.

A study was made of the reduction of trimethylamine oxide to trimethylamine in marine fish held at different storage temperatures. Samples of fish used included haddock in the round, fresh and frozen haddock fillets, and cod muscle press juice. In the haddock samples, only negligible amounts of trimethylamine resulted from sources other than trimethylamine oxide. Data obtained from the other samples indicated that the determination of trimethylamine was not always a reliable test for freshness. Thus the value and usefulness of the test is limited.

Tests involving the reducing of trimethylamine oxide *in vitro* by different bacteria indicated that the oxidation-reduction potential has a bearing on the reduction of the oxide to trimethylamine. Bacteria which were able to reduce the oxide created a reducing atmosphere in the medium. Aeration of the medium inhibited the reduction.

Attempts to obtain a bacterial-cell-free preparation of triamineoxidase, the enzyme responsible for the reduction of trimethylamine oxide to trimethylamine, were unsuccessful.

Home Preservation of Herbs. (W. B. Esselen, Jr., and S. Yang.) Work has been continued on the home preservation of such herbs as basil, marjoram, summer savory, mint, sage, burnet, thyme, and dill. Drying in an attic or in the shade or in a cabinet with forced-air circulation gave the best retention of essential oils in herbs. With a number of different herbs studied, mid-day was the best time to harvest them as their essential oil content was higher then than in the morning or late afternoon. Fresh herbs were quite satisfactory when frozen without being blanched, although they tended to darken when thawed. Blanching prior to freezing is not recommended because it causes a loss of most of the essential oil. Mint syrup and dill, dill and garlic, basil, and burnet vinegars have been prepared. Burnet vinegar has a tendency to turn black upon exposure to the air, apparently because of the iron content of the burnet. Such discoloration can be prevented by the addition of an antioxidant such as ascorbic acid (vitamin C) or a chelating agent such as "Sequesterene" (the disodium salt of ethylenediaminetetracetic acid).

Factors Influencing the Mold Content of Cranberries. (W. B. Esselen, Jr., and C. R. Fellers.) Ninety samples of fresh cranberries from different bogs and commercial canners were collected during October, November, and December 1949. They were made into sauce and their mold count determined. The mold counts of sauces made from sound fruit ranged from 0 to 12 and were in general agreement with similar mold count tests made during the 1947 and 1948 seasons.

Utilization of Massachusetts Fruits for Home Wine Making. (W. B. Esselen, Jr., E. E. Anderson, I. S. Fagerson.) During 1949 experimental lots of wine were made from sweet cherries, currants, elderberry blossoms, raspberries (both red and black-cap), blackberries, blueberries, peaches, and pears. Acceptable wines were made from all the fruits with the exception of blueberries. The addition of 4 grams of ammonium phosphate, ammonium nitrate, or urea per gallon of must as a yeast nutrient improved the rate of fermentation and quality of the fruit wines.

Processing Atlantic Tuna Fish. (C. R. Fellers.) The "little tuna" (*Euthynnus alleteratus*), which is abundant off the New England Coast, was frozen and canned. This fish weighs about 9 to 15 pounds and is a light-meat tuna of very good quality. Methods of fishing have not been perfected as yet. This fish makes a good quality canned product. As with the Pacific tunas, the "little tuna" must be first steamed to eliminate the strong-flavored body oil before packing with bland vegetable oil.

Pre-Peeled Potatoes. (E. E. Anderson, K. C. Li, and W. B. Esselen, Jr.) Preliminary work has been done on methods of preventing discoloration of peeled white potatoes. The preparation of such potatoes for distribution to hotels and restaurants is becoming an increasingly important enterprise in this area. When peeled potatoes are dipped in a solution containing 3000 p.p.m. of sulfur dioxide they may be kept for 10 to 15 days under refrigeration (35° to 40°F.). The thiamine content of such treated potatoes was well retained.

Factors Influencing the Composition and Characteristics of Cranberries. (W. B. Esselen, Jr., E. E. Anderson, and C. Flynn.) (In cooperation with the Massachusetts Cranberry Experiment Station and the National Cranberry Association, East Wareham, Massachusetts.) Ten crosses of cranberry varieties grown on

two different bogs in New Jersey were analyzed for color, acidity, pectin, ascorbic acid, flavor, and jellying properties. The bog on which the cranberries were grown had a significant effect on the properties and characteristics of the fruit, and also influenced the yield and quality of cranberry sauce made from the fruit. While these observations are of a preliminary nature, they point to the desirability of making a similar and more extensive study on Massachusetts cranberry bogs. Such an investigation has been scheduled for this coming season.

Investigations on Cranberry Juice. (E. E. Anderson, W. B. Esselen, Jr., F. Langevin, and I. S. Fagerson.) Cranberry juice was prepared from frozen cranberries using both hot and cold extraction methods, with and without pectinase treatments. The resultant juice was packed in glass and tin containers, stored under varying conditions of light and temperature, and analyzed periodically for color and flavor changes. Ascorbic acid and sodium pyrophosphate were of little or no value in preventing color deterioration in the stored product. Attempts to produce darker colored juices by re-extraction of the residual cranberry pulp, vacuum concentration of the extracts, and finally adding the concentrate back to the original juice were not judged to be commercially feasible or practical.

Influence of Pyrophosphates in the Manufacture of Cranberry Sauce. (E. E. Anderson and W. B. Esselen, Jr.) Recently the claim has been made that the use of "molecularly dehydrated phosphates," such as crystalline pyrophosphates, acid pyrophosphates, tripolyphosphates and metaphosphates, in the manufacture of red fruit products resulted in improved retention of the red color, inhibition of the darkening of these products during storage, as well as increased yields and gel strengths. In an attempt to substantiate the above findings with respect to the manufacture of cranberry sauce, samples were prepared with sodium pyrophosphate. Concentrations of 0.44, 0.88 and 1.73 percent sodium pyrophosphate were selected inasmuch as 0.8 percent was originally recommended for best results. Examination of the samples after a six-month storage period revealed a marked discoloration in all samples containing sodium pyrophosphate. The sauce at the headspace was colored a very light purple to a depth of one-eighth to one-quarter inches. The flavor in the sauce containing 0.44 percent pyrophosphate, while not objectionable, was somewhat blander than that of the controls. However, a decided off-flavor appeared in those samples containing 0.88 and 1.73 percent pyrophosphate. Although the gel strength of the samples with 0.44 and 0.88 percent pyrophosphate approximated that of the controls, the use of 1.73 percent pyrophosphate resulted in little or no gel formation.

Effect of Manufacturing Processes on the Vitamin C Content of Cranberry Sauce and Cocktail. (J. J. Licciardello, W. B. Esselen, Jr., and C. R. Fellers.) Fresh cranberries have been found to contain a significant amount of ascorbic acid; however, cranberry products are practically devoid of this vitamin. An investigation showed that, when the fresh berries were converted into sauce or cocktail, there was a progressive decrease in the vitamin C content incurred by each major operational step. It was further demonstrated that the destruction of the ascorbic acid was due to oxidation. In the manufacture of the sauce the oxidation was accelerated by the high cooking temperature and metal catalysts; whereas, in the production of the cocktail, the oxidation was promoted by the presence of oxidizing enzymes and metal catalysts.

Moisture Equilibrium Studies. (A. S. Levine, I. S. Fagerson E. A. Nebesky, J. Cage.) This investigation has been continued and sorption and desorption isotherms for several foodstuffs have been determined. This type of data is

generally not easily available and is valuable in determining packaging requirements and storage life of the food materials in question. A simplified procedure which was developed for determining these sorption and desorption isotherms gave results in good agreement with standard methods.

Studies on the Mechanism of Heat Transfer in Commercial Glass Containers during Thermal Processing. (I. S. Fagerson and W. B. Esselen, Jr.) Some of the factors which influence the heating rates in commercial glass containers during thermal processing have been investigated.

Time-Temperature Distribution Patterns in Commercial Jars.—Data have been obtained for commercial 303 and 2½ size jars at initial temperatures of 140° and 180°F. processed with steam under water at 240°F. One percent bentonite suspensions were used for convection type heating and 5 percent bentonite for conduction type heating.

In the 5 percent suspensions the patterns showed an initial lag period as indicated by a small temperature differential between points near the center of the container as compared to the differential between the wall and the outermost thermocouple. Following the lag period, the temperature rose more or less uniformly from the center to the wall of the container. It was noted that, though the metal lid of the container has a greater thermal conductivity than the glass wall, this did not appear to affect significantly the characteristic patterns of simple conduction heating across the central horizontal plane which is similar in form to patterns obtained for 5 percent bentonite suspensions in cans.

In the 1 percent suspensions the patterns obtained appeared to confirm Jackson and Olson's hypothesis on the mechanism of heat transfer in cans. Further confirmation was obtained by studying the direction and distribution of convection currents on introducing methylene blue into containers filled with water and recording the resulting currents by means of motion pictures as the jars were heated in a constant-temperature bath.

Process Value Distribution.—Process value or F_0 value distribution have been obtained for both sizes of containers for both convection and conduction type heating using the bentonite suspensions previously mentioned.

In conduction type heating F_0 values were at a minimum at the approximate geometric center of the container. This is in agreement with theory and confirms the generally accepted locale of the cold point. When this region has received the desired process value all other points are overprocessed.

In the case of convection heating, it was noted that zones intermediate between the jar wall and the vertical axis of the jar and in the same horizontal plane as the usually accepted "cold zone" showed F_0 values lower than points on the vertical axis. This observation is of significance in that cold zone determinations are generally based on the assumption that the critical zone is centered on the vertical axis of the container, heat penetration tests usually being carried out to ascertain the height on the axis where the process value is at a minimum. This phase of the work is being continued, present studies being carried out to determine the magnitude of this effect in containers of actual foods which exhibit convection heating.

Radiation as a Mechanism Heat Loss During Air Cooling of Glass Containers.—Radiative heat loss in air from 303 size glass containers was compared with that of a No. 2 plain tin as well as fruit and "C" enameled cans. It was found that comparatively large amounts of radiation occur from the plain glass containers when filled with 1 percent bentonite suspensions and cooled in air. This radiative heat loss is greater from plain glass than from tin containers.

Factors for Converting Heating Rates from One Jar Size to Another.—In calculating a thermal process for foods according to mathematical methods it is necessary to know the temperature of the food in the container during the sterilization period. Usually time–temperature relations are determined experimentally. Often these tests are made with only one size of container and at a later date it may be desirable to know what these relations would be if the same product were packed in a container of different size. It is therefore desirable to have some means of calculating heat penetration data for one container size to the equivalent for another size.

It was found that available formulas for converting heating rate data in cans of food heating by conduction as represented by 5 percent bentonite suspensions are applicable to glass containers of dimensions similar to the 2½ and 303 size containers.

Relationships for converting heating rate data in cans of food heating by convection are not applicable when applied to glass containers. Accordingly, two empirical relationships for conversion of heating rate data in glass were developed which give good agreement with experimental values as determined in 1 percent bentonite suspensions.

Mechanisms of "Broken-Curve Heating".—Attempts to obtain broken heating curves in 303 size jars utilizing 3¼ percent bentonite suspensions were not successful. It was found that such curves were obtained with 2 percent suspensions. The use of materials other than bentonite for the production of broken curves was investigated, among these the 100 and 500 cp grades of Dow Methocel, Du Pont Carboxymethylcellulose, Du Pont Ludox (a colloidal dispersion of hydrated silica), Du Pont polyvinyl alcohol, and Vulca 30 (an ether derivative of ungelatinized starch), none of which proved suitable.

A study on the role of retort come-up-time on the production of broken curves utilizing the 2 percent suspensions indicated that increasing the come-up-time had the general effect of shifting fh values from those representing convection to those representing conduction type heating. Under the conditions of the experiments, the maximum value of come-up-time which leads to the production of broken curves is approximately three minutes.

The Effect of Ethylenediaminetetracetic Acid (Sequesterene) on the Copper and Iron Catalyzed Destruction of Ascorbic Acid. (W. Averill and C. R. Fellers.) The protective effect of ethylenediaminetetracetic acid on the copper, iron, and copper plus iron catalyzed destruction of ascorbic acid was studied in phthalate buffers of pH 2.5 to 6.0. Ethylenediaminetetracetic acid was very efficient in its ability to inhibit the copper-catalyzed oxidaztion of ascorbic acid in this pH range.

The presence of ferrous ions did not greatly increase the rate of oxidation of ascorbic acid but did increase the amount of ethylenediaminetetracetic acid required to inhibit the copper-catalyzed oxidation of ascorbic acid.

Date Investigations. (C. R. Fellers, I. Rashid, and M. S. Rahman.) For the first time, analyses of date protein for the indispensable amino acids has been made. Enzymes are responsible for most of the physical and chemical changes which take place in dates during ripening. Canned dates, date paste, and other date products have been prepared using both Egyptian and California dates.

Vitamin D Investigations. (C. R. Fellers, L. R. Parkinson, and K. C. Li.) It has not been possible to use proposed chemical and spectrophotometric methods for the estimation of the vitamin D content of milk. Check rat assays on vitamin

D milks produced in the State show that the 400 unit per quart guarantee is being complied with.

Non-Toxicity of Ethylenediaminetetracetic Acid (Sequesterene). (C. R. Fellers, L. R. Parkinson, and S. S. Yang.) This complexing (sequestering) agent has been suggested for the neutralization of heavy metals in foods, beverages, brines, syrups, and sea foods. Hence, it is of great importance to ascertain the toxicity of the compound.

Feeding experiments with albino rats have been under way for 20 months. Daily feeding levels of 0.25, 0.5, and 1.0 gram have resulted in no observable change in the gross appearance of the animals or their organs. Neither has there been any appetite or weight loss. It is concluded that the disodium salt of ethylenediaminetetracetic acid is non-toxic and is suitable for use in foods. The quantity required for neutralizing (chelating) copper is approximately 5 p.p.m. for each p.p.m. of the metal.

DEPARTMENT OF FORESTRY AND WILDLIFE MANAGEMENT
R. P. Holdsworth and R. E. Trippensee in Charge

The Effects of Seedbed Treatment on the Natural Establishment of Eastern White Pine. (Arnold D. Rhodes.) In August 1947, sixteen one-fortieth acre plots were established under an even-aged stand of eastern white pine approximately fifty years old, which, because of poor form and quality, was about to be clear-cut. Four conditions of seedbed were created as follows, each replicated three times: removal of the forest floor by burning, removal by raking, scarification of the floor by turning a tractor on one tread, and retention of the floor undisturbed (control).

A heavy crop borne that fall deposited seed at the approximate rate of 400,000 seeds per acre as determined by eight seed traps. The actual number of seeds which fell upon any one plot is not known. During the ensuing winter the pine was harvested, and all woody vegetation except the smallest shrubs was cut back to the ground. All cut material and logging slash were removed from the plots, leaving the cutting area without overhead shelter and protection against solar radiation. Germination of seed and survival of seedlings were recorded at weekly intervals during the spring and early summer of 1948, and at longer intervals later. Results after two years of observations are as follows:

1. Germination was adequate by any form of treatment, including undisturbed forest floor, and does not appear to pose a problem. Conditions influencing survival are the critical factors.
2. Initial survival was favored by the development of herbaceous growth, which protected seedlings against high temperatures. Such development was most rapid on raked plots, least on control plots, and intermediate on the others.
3. Second-year survival was reduced materially by the competitive effects of both herbaceous and woody vegetation, which became established in abundance on all plots except the control. In short, survival was poor on undisturbed forest floor for want of shade, and poor on disturbed forest floor because of competition.
4. After two years the percentage of survival for the four treatments—control, burning, scarification, and raking, respectively—was 3, 21, 21, and 34, the number of high-vigor seedlings per acre was 0, 800, 1,400 and 2,400, and after one year the number of woody stems other than pine per acre was 3,000, 11,800, 14,600, and 79,700.

Significance: Clear-cutting in large units, with or without disturbance of the seedbed, discourages the ultimate establishment of white pine even when the

seed supply is abundant. The most satisfactory system of regeneration would appear to be a partial cutting such as shelterwood, group selection, or clear-cutting in narrow strips or small blocks, which leaves larger trees to provide shade and shelter, at the same time leaving the forest floor intact where possible as a check against establishment of competition. Experimental studies are being continued to test this hypothesis.

Factors Affecting Damage to Communication Cables by Squirrels, and the Possibility of Developing Means of Preventing Such Damage. (Raymond Sherman and R. E. Trippensee.) This is a continuation of the study of gray squirrel damage to lead and plastic covered telephone cables, carried out in previous years by Paul A. White, Wesley Jones, and R. E. Trippensee. The number of squirrel cages was increased to 18 and the number of squirrels tested varied from 16 to 24. Squirrels were tested singly and in pairs. Cables of various sizes and with both lead and polyethylene coatings were used. Tests were run with a variety of diets, all, however, included the basic fox chow feed and water. Two squirrels were born in captivity to a female placed in the cage without a mate on January 8, 1950. No accurate record could be obtained as to when the young were born.

Records were kept of the degree of damage to both lead cable and alpeth. These were tried untreated and treated with several repellents. Those used were as follows:

Experiment 2. Burbank's coon and weasel scent, made for Sears, Roebuck & Company, and Goodrite Z.A.C., zinc dithiocarbonate amine. These repellents did little to discourage chewing, in fact, they seemed to attract squirrels, as the damage was heaviest where they were applied. This might, however, be due to the fact that it was given to squirrels that do the most chewing.

Experiment 3. Four different repellents were used. Diamond tree paint produced good results, the damage was very slight. A rabbit repellent, 96A, proved very unsatisfactory, the damage was greater where it was applied than where it was left off. Rabbit repellent 252 was unsatisfactory, results were the same as on untreated cable. Goodrite's Z.A.C. proved more successful in this experiment, but from previous results in Experiment 2 it is not recommended as a squirrel repellent.

Experiment 6. A hose was tested to which was applied Ensign No. 369, both clear and brown. The treated hose was damaged far less than the untreated hose, but damage was not completely prevented.

As to over-all results: The cable damage in this last experiment, No. 6, was somewhat under average, but damage to cages and boxes was far above average. When cage and cable damage was coupled together, the average showed an increase in the total amount of damage. Also this experiment showed greater damage from female adults than from male adults, which had not previously been the case. Young of either sex seem to cause much damage also. The two young squirrels born at the wildlife laboratory this spring did 2.6 times more damage than the average for adult squirrels. There were, however, individual adults that did greater damage.

Testing of Material Which May Retard Seed Damage by Rodents. (Wesley R. Jones and R. E. Trippensee.) Several small rodents were used for this test: domestic white mouse (*Mus musculus*), common house mouse (*Mus musculus*), and white-footed mouse (*Peromyscus leucopus*). Dry repellent was dusted on kernels of corn or corn was immersed in a solution of the repellent. In this way the repellent adhered to the surface of the corn. Fox checkers and water were available in sufficient quantity. None of the nine materials tested seemed to

have any retarding effect on the several rodents. All ate the treated corn without any hesitation. No degree of difference could be detected between any of the repellents tested.

Factors Influencing Use of Artificial Nest Boxes by Wood Ducks. (James L. Chamberlain.) Before the nesting season of 1949, State Conservation Department personnel erected 62 artificial wood duck nesting boxes at Great Meadows Refuge in Concord, Massachusetts, as part of a state-wide effort to increase wood duck populations. To test the effectiveness of this technique, a detailed study was begun in the spring of 1949 by personnel from this Institution. The results of the first season's study may be summarized as follows:

Twenty-five broods comprising a total of 306 ducklings were produced in the 62 boxes on the refuge. While 73 percent of the boxes were utilized, 20 failed to produce broods. Circumstantial evidence indicated that many hens lay eggs in more than one box, thus accounting for the unproductive clutches.

The study was continued in 1950 by personnel of the State Division of Fisheries and Game.

Cooperators in this and the four following projects: U. S. Fish and Wildlife Service, Massachusetts Division of Fisheries and Game, the Wildlife Management Institute, and the University of Massachusetts.

Ecology and Management of the Muskrat in Massachusetts. (James L. Chamberlain.) This study was started in 1949 with the objective of determining the present status and economic value of the muskrat in Massachusetts and recommending the soundest management policy.

A detailed ecological study of this furbearer has been started at Great Meadows Refuge in Concord. Approximately 75 animals have been trapped, tagged, and released. Data on age and sex ratio, movements, reproduction, and condition have been recorded. In conjunction with this study a vegetative map has been made of the marsh area, and some marsh management experiments have been carried out.

In addition, a state-wide survey has been made to find the areas yielding the largest number of muskrats. Several hundred pelts have been examined and graded for primeness and sex and age ratios. Records have been kept by cooperators on the kind of habitat where these graded pelts were taken. Pelts become prime earlier in the year in western Massachusetts than on the east coast. In all areas, most of the muskrats are trapped early in the season before the coats are fully prime.

Experimental Land Management Techniques to Increase the Population of Cottontail Rabbits. (Francis H. Fay.) The main objective of this study is to work out techniques of managing submarginal abandoned farmlands so that a maximum number of cottontail rabbits can be produced. Work of clearing and planting has been begun on an experimental 90-acre plot in the town of Upton.

Woodcock Studies. (William G. Sheldon.) Original techniques have been developed for banding adult woodcock on their breeding grounds in Massachusetts. In the spring of 1950, 96 birds were captured, banded, and released. In addition, two annual censuses have been made of woodcock populations in the central part of the State. Other cooperators have been solicited to make this a state-wide study. As banded birds are returned and cooperators' annual reports analyzed, a more complete record will be made of the status of the bird in this State. Basic ecological facts will also be sought and thus contribute to wiser national management policies for this economically important migratory upland game bird.

Factors Affecting the Population of Ruffed Grouse. (C. F. Banasiak and William G. Sheldon.) In the spring of 1949 research was begun on ruffed grouse, with the main objective of learning whether gunning pressure or land changes are of greatest importance in affecting population changes. Detailed studies of two representative areas are being conducted, and over four hundred pertinent observations of these birds have been recorded. Census data are recorded regularly to keep abreast of the monthly and annual population shifts of this species.

DEPARTMENT OF HOME ECONOMICS NUTRITION
Anne Wertz in Charge

The Nutritional Status of Pregnant Women. (A. W. Wertz, M. E. Lojkin, P. Van Horn, G. C. Hagan, and C. E. Greenfield.) As reported previously (Mass. Agr. Exp. Sta. Bul. 449, p. 58, 1948) this project is part of the Northeast Regional Cooperation Project on Nutritional Status and is being done with the cooperation of Dr. Eugene M. Holden of Amherst. Fifty-five pregnant women have been studied to date. As the project will continue for at least another year, it is not yet feasible to evaluate the data accumulated thus far.

A Study of the Methods for Obtaining Dietary Histories. (G. C. Hagan, A. W. Wertz, P. Van Horn, and C. E. Greenfield.) Sufficient data have been collected on this study for statistical analysis and evaluation, which is now being made. The results and recommendations are not yet available.

Relation of Ascorbic Acid in Umbilical Cord Blood, Maternal Blood, and Maternal Diet. (A. W. Wertz, C. E. Greenfield, G. C. Hagan.) It has been possible to date to obtain the cord blood from 15 women at parturition and analyze it for ascorbic acid. The ascorbic acid in the cord blood ranged from 0.95 to 3.64 milligrams percent with an average of 1.92 milligrams percent. The ascorbic acid in the blood of these same women during the last month of pregnancy ranged from 0.37 to 2.72 milligrams percent with an average value of 1.13 milligrams percent. These results indicate that the average ascorbic acid value of the cord blood is approximately 70 percent higher than the average value for maternal blood. However, in the cases studied, no correlation was found between the amount of ascorbic acid in cord blood and maternal blood. Neither was any correlation found with the amount of ascorbic acid in the maternal diet which ranged from 22 to 123 milligrams per day with an average value of 75 milligrams. Additional data are being collected on this study.

Relation between Nicotinic Acid in Umbilical Cord Blood and Maternal Diet. (C. E. Greenfield, G. E. Hagan, and A. W. Wertz.) In the 21 subjects studied so far there appears to be no correlation between the amount of nicotinic acid acid ingested in the diet and the amount of nicotinic acid found in the umbilical cord blood. The nicotinic acid content of the diet ranged from 5.1 to 19.8 milligrams daily with an average of 12.5 milligrams. The cord blood values ranged from 10 to 104 micrograms per 100 milliliters with an average of 55 micrograms per 100 milliliters. This study is being continued.

Nicotinic Acid Metabolism in Pregnant Women. (M. E. Lojkin, A. W. Wertz, C. E. Greenfield, and G. C. Hagan.) In 100 percent of the women studied there was a higher urinary excretion of N-methylnicotinamide during pregnancy than in the non-pregnant state. This increase is most marked in the latter months of pregnancy. In about 75 percent of the cases studied there was a slight increase in the amount of nicotinic acid excreted during pregnancy. In many cases the

amount of nicotinic acid metabolites that are excreted in the urine exceeds the amount of nicotinic acid ingested in the diet.

Nicotinic Acid Metabolism in the Pregnant Rat. (M. E. Lojkin, C. E. Greenfield and A. W. Wertz.) To further the study of nicotinic acid metabolism during pregnancy, the albino rat was used as an experimental animal. The results showed that the urinary excretion of nicotinic acid and N-methylnicotinamide increased during the latter stages of pregnancy, in some cases being highest on the day of parturition. The excretion of N-methylnicotinamide did not drop to normal levels until several days after the birth of the young. The increase in the excretion of nicotinic acid metabolites during pregnancy does not appear to be correlated with the increase in weight of the animal or with the amount of nicotinic acid ingested.

DEPARTMENT OF HORTICULTURE
Clark L. Thayer in Charge

Study of Herbaceous Perennial Material. (C. J. Gilgut and Paul Bobula, Waltham.) The test garden of herbaceous perennial ornamental plants adaptable to our local climatic conditions was maintained in a presentable and attractive condition in spite of the extremely dry summer.

Forty-four plants were lost in the garden, either because they could not survive growing conditions or because they lacked garden value and were removed. In addition, out of ninety named chrysanthemums which are so-called hardy types only twelve lived over winter. It is increasingly apparent that the term "hardy" is a misnomer when applied to most garden chrysanthemums. Fifty-eight new plants were placed in the garden as replacements or as introductions newly available in the trade.

The test garden continues as a source of information on garden value, hardiness, cultural requirements, and flowering habits of plants for New England conditions that is available nowhere else, and continued public interest is indicated by the regular visits of large numbers of people who come to observe and study these plants.

The phlox collection was extended with new varieties for studies of trueness to name and garden value. It is evident that garden phlox are in a chaotic state regarding names, many being offered to the public under several names. This group of plants needs additional study.

The hemerocallis collection is now well established and receiving critical study for garden value.

Contrary to reports of some investigators, foliar nematode of hardy garden chrysanthemums was not controlled by parathion sprays, nor was chlordane or benzene hexachloride effective. The treatments will be repeated this season.

Factors Influencing the Rapidity of Growth of Nursery Stock. (C. J. Gilgut, Waltham.) Leaf bud cuttings of named varieties of rhododendron were taken in September, October, November, and December in an effort to obtain large enough percentages of rooting to make the practice commercially feasible. Rooting was better in sand–peat mixture than in sand alone when cuttings were treated with commercial hormone powders or with indolebutyric acid using 60 mg. per liter for 24 hours. Results, however, were disappointing since the number rooted, particularly of the more desirable named varieties, was small. The shortage of good named varieties of hybrid rhododendrons on the market makes it desirable to continue investigation of practical methods of propagation.

Fifteen hundred seedlings of a red variety of rhododendron have been lined out for the purpose of color selection and, specifically, to determine whether such selections will root more easily from leaf bud cuttings than named varieties now in commerce.

Rooted cuttings and seedlings of nursery stock lined out in the summer often suffer severe bark injury from early hard frosts and wood injury from cold, during the first winter. It is believed this is caused by heavy fertilizer applications and failure of plants to harden off sufficiently and mature early enough in the fall. Plots of *Thuja occidentalis*, *Taxus capitata*, *Rhododendron poukhanense*, *R. carolinianum*, *Azalea molle*, *A. kaempferi*, and *A. mucronulatum* were treated with 1 ton per acre of cow manure, castor pomace, Spurz-on (commercial hen manure), or 5-8-7, 1500 pounds per acre of superphosphate and muriate of potash. Before hard fall frosts one-half of each plot was hilled up to determine the effect of this cultural treatment on prevention of injury.

There was no frost or winter injury on any of the plants, including those which received no treatment; therefore, applications of fertilizer as the cause of frost injury could not be determined. Effect on growth, however, was evident. Best for all varieties was castor pomace and next was Spurz-on. Manure was poor, and 5-8-7, muriate of potash, and superphosphate at the rates applied caused some injury, no doubt due to the extremely dry conditions which prevailed after application, although an effort was made to keep the plants watered.

Control of Weeds in the Nursery by Chemical Sprays. (C. G. Gilgut, Waltham). Sovasol No. 5 was applied to nursery plants, as in previous years, with a hand sprayer because of the need of careful control of spray to avoid injury to susceptible, valuable ornamental plants. Results of previous work were verified and confirmed. (See report for 1949.)

As a pre-emergence weed killer for gladiolus bulblets, Sovasol No. 5 was again found to be effective. It is better than 2, 4-D preparations which do not kill grasses.

The 2,4-D preparations, Esteron 245, Sherwilkil No. 2, Weedone 32, Weedar 64, Easteron 44, and Weednomore were less effective for control of ordinary weeds in the nursery than Sovasol No. 5 but were more effective for brush killing.

DuPont TCA 60 percent (trichloracetate) was applied to witch grass during the extremely dry period in August. The following spring there was 95 and 90 percent reduction of spring growth of witch grass where 200 and 150 pounds per acre was applied, 80 percent with 100 pounds per acre, and less than 40 percent with 60 pounds per acre.

DEPARTMENT OF OLERICULTURE
Grant B. Snyder in Charge

Asparagus Investigations. (Robert E. Young, Waltham.) In a breeding experiment to develop a higher yielding strain of asparagus, the past year's records continue to indicate the superiority of the selected lines over the commercial varieties. The average yield of the four top-producing strains was 100 pounds per plot as compared to 57 pounds for the two commercial varieties.

In the second full cutting season the yield did not increase as expected but showed a 4 percent reduction from the previous year. This is attributed to dry weather during the cutting season. The dry weather also caused 25 percent reduction in the number of summer stalks produced. The better-producing strains did not show as much reduction as the poor ones.

Individual plant yield records were made on four strains in order to isolate better parent material for future use. The average weight of spears from these plants was 0.96 pound per plant. The top ten plants in each strain produced more than 1.6 pounds per plant, and only 14 percent of the plants in these four strains produced less than ½ pound per plant, indicating uniformly good production from almost all plants. Since there is some variation in the yield of individual plants from year to year, records must be obtained for several seasons before the best parent material can be selected for release to growers.

Vegetable Breeding for Improvement of Quality. (Robert E. Young, Waltham) Progress has been made in the development of strains of Butternut squash, celery, and cabbage better adapted to local use. Work was along the lines previously indicated, but new developments are not conclusive enough to warrant detailed report at this time.

Broccoli.—In 1949 the fall crop of broccoli produced results that demonstrated the superiority of Waltham No. 11 and Waltham No. 29 strains over commercial varieties. In order to harvest all of the crop as it developed, it was necessary to cut the commercial varieties eight times while only four or five harvests were necessary for Waltham 11 and 29. The No. 11 produced approximately 10 percent more marketable crop than the commercial varieties. The No. 29 does not produce a greater yield but it will stand hot weather without opening up and blossoming.

Replicated trials in the spring of 1950 showed that Waltham No. 11 produced 16 percent more total yield and 25 percent greater yield of marketable shoots than did the average of the five most widely used commercial varieties. This strain is now being tried by many growers on a larger scale.

New York Type Lettuce.—An experiment was set up to determine possible cause of the development of a cone-shaped head in the variety Penn Lake lettuce. This trouble occurred in many fields in Bristol County in 1949, and in some instances 50 percent of the plants were affected. The trouble does not occur when the same seed is planted directly in the field.

The results of this experiment showed that, where the plants were planted deep, well over 50 percent of the heads were cone-shaped and all were very small. Where the plants were planted on a small ridge, all heads were round and very large. From one year's results, it appears that planting Penn Lake lettuce on a ridge will eliminate the cone-shaped head.

Trellis Tomatoes.—The use of an A-type trellis for the production of trellis tomatoes is becoming increasingly popular with the growers. It is a system of planting two rows 2 feet apart and training to a single trellis. The space between the trellised plants is 6 feet, which allows for the use of machinery for spraying. This method has greatly reduced the cost of production.

Trials were conducted to see what effect this new method has on production, and one year's results indicate a good increase in the percentage of No. 1 fruit. There was a slight reduction in the average size of fruit. The greatest difference observed in this experiment was in the reduction of total yield by the A-trellis method. Whether or not the reduction in the cost of production and the increase in No. 1 fruit are sufficient to offset the loss in yield can be determined only after several more trials of the system.

Breeding to improve our strain of trellis tomatoes by the incorporation of resistance to cracking has progressed to the third generation and some of these strains have shown only half the cracking of Trellis No. 22. Late maturity has been associated with the crack-resistant character, and these third generation

strains are slightly later than Trellis No. 22, but back crosses have been made to overcome this tendency.

Last year a report was made on the fruit set and yield of trellis tomatoes when the blossoms were sprayed with hormones. That was in a year when below-normal temperatures existed for two weeks after the plants were set in the field. In 1949, the experiment was repeated and the temperature was above normal, a condition which favors normal setting of fruit. The hormones produced an increase of 6 percent in set of the first cluster but a reduction of 8 percent in the set of the second cluster. The yield from these plots is in favor of the hormone treatment by 11 percent for the first two pickings and 4 percent for the third and fourth. There was no significant difference in the total yield. From two years' results, it would seem that the application of hormones to trellis tomatoes is a practice that can be recommended.

Greenhouse Tomatoes.—In an experiment to determine the value of hormone sprays in the greenhouse, the bottom or first cluster of the spring crop of tomatoes was sprayed three times. Those clusters that were not sprayed set 53 percent of the flowers while the hormones produced a set of 95 percent. The second cluster was not sprayed, to see whether the heavy set induced by the hormone affected the sets above. Where the plants had been treated for the first cluster, the second cluster set only 45 percent of the flowers, while 54 percent set on the check plants. In the third cluster the plots were reversed and again the hormone produced a set of 70 percent as compared to 40 percent for the no treatment.

The first three weeks of harvest showed that the plants sprayed with hormones produced twice as much fruit as the untreated. The quality of the fruit where it was set artificially was not as good but the increases in production were so outstanding that the treatment is suggested for growers when the weather is adverse and the blossoms fail to set naturally.

In trials in both the spring and fall, the greenhouse hybrid tomato (Waltham Forcing X Michigan State Forcing) produced more fruit than the Waltham Forcing. The percentage of No. 1 fruit was higher, also. In a few of many trials in growers' houses, the fruit has been too large. For those growers who have difficulty in getting sufficient size with the regular variety, the hybrid is recommended.

Carrots.—The carrot breeding work in which the objective is a better-colored Hutchinson carrot has progressed to where the two best selections are being multiplied for trial on growers' farms. The best of these, a cross between Hutchinson and Imperator, produced a much larger percentage of marketable roots than did the Hutchinson.

In a carrot spacing experiment to determine the most advantageous spacing for the production of the small-sized roots now demanded in the market, the largest production of No. 1 roots was obtained with the closer spaced rows. When only three rows were planted in a 57-inch bed, as many as 15 percent of the crop were too large, which compares with 0.9 percent for six rows to the bed. While this experiment must be repeated many times for conclusive results, the data indicate that more bunches of marketable carrots can be harvested per acre if the rows are not over 12 to 14 inches apart, instead of the 18-inch spacing used by some.

Weed Control in Vegetable Crops. (William H. Lachman.) Tests were conducted where twenty-three different treatments were applied to a field of North Star sweet corn for the control of weeds. All of the treatments were pre-emergence applications of the chemicals, i.e., applied after planting but before the emergence of the crop.

All weeds except smartweed were controlled for a period of four weeks by 2,4-D applied at 1.5, 2.0, or 3.0 pounds per acre. It was evident that smartweed is very resistant to 2,4-D in pre-emergence applications. These treatments caused the malformation known as onion-leaf in the corn, with increasing severity as the rate of 2,4-D was increased. While the yield of corn was not significantly lower on the 1.5 pounds per acre plots than on the control plots, the 2.0 and 3.0 pounds per acre treatments did reduce the yield significantly. Applications of 2,4-D delayed until the crop was barely emerging from the soil were superior to treatments made just after planting time.

Sodium pentachlorophenate, a wood preservative, applied as a spray at the rate of 10, 20, or 30 pounds per acre proved to be among the best of the treatments, with 20 pounds of this chemical perhaps giving the most satisfactory and economical control. Excellent control of all annual weeds for a period of four to five weeks resulted from this treatment.

Applications of 1.5, 2.0, 3.0, 6.0, or 9.0 pounds of dinitro-o-sec-butyl-phenol (DNOSBP) and duplicate treatments with the ammonium salt of this chemical were also made. From 3.0 to 6.0 pounds were necessary to control weeds adequately, and 9.0 pounds proved to be deleterious to the corn. It appeared that DNOSBP and its ammonium salt were comparable, on a pound for pound basis.

Sulfasan at 5.0 or 10.0 pounds per acre gave no perceptible weed control. Later tests indicated that at least 50.0 pounds of this material per acre were required to kill weeds. Cyanamid applied at the rate of 400 pounds per acre immediately after planting gave very poor control. Later tests indicated that it was necessary to delay the application for seven to eight days after planting in order to obtain good weed control from Cyanamid. This treatment was effective in promoting nitrogen stimulation of the corn.

A mixture of 1.0 pound of 2,4-D and 10.0 pounds of sodium pentachlorophenate was not outstanding in its control of weeds, and about 3.5 percent of the corn plants were malformed.

It was readily apparent that none of the tests were effective to the extent that weeds would remain controlled all through the season. Even where good control of weeds resulted, it was necessary to cultivate four or five weeks after treatment with the chemicals. Nutgrass, a member of the sedges, was not affected to any marked extent by any of the treatments mentioned.

A number of materials applied to snap beans in pre-emergence applications again showed the value of a 20.0 pound per acre application of sodium pentachlorophenate. This treatment caused a definite chlorosis to appear on the first pair of bean leaves, but this condition was not present at any later stage of growth.

Breeding Sweet Corn, Peppers, and Field Tomatoes for Massachusetts. (W. H. Lachman.)

Sweet Corn.—Gold Mine (Mass. 2410-191 x C3) has been planted in widely scattered tests and in some cases has produced edible corn in 56 days from planting. This hybrid has repeatedly demonstrated its cold resistance and extra earliness. It is interesting to note its extreme cold resistance when made with the Mass. 2410-191 line as the female parent as opposed to the use of C3 as the female parent. Work is being continued to improve the stiffness of stalk, ear appearance, and quality. C12 and C2A were also used in making three-way and double crosses.

Golden Jewel has been judged to be almost as good in quality as Golden Cross Bantam, and it seems to retain this quality when frozen. Wide-scale testing this year definitely places its season of maturity between Marcross and Carmelcross.

The attempt to develop an early Golden Cross Bantam type of plant and ear has been carried on to the extent that a large number of early seed parents are now available for testing, but desirable early pollen parents are still in the developmental stage.

The final crossing was accomplished to make a sixteen inbred hybrid. This material is now ready for self-pollinating in order to obtain new combinations of germ plasm for further breeding work.

An F_2 population from Fort Kent Flint x Early Mass. 32 proved to segregate plants that were exceptionally early. In fact, some plants were three or four days earlier than C3, our earliest sweet corn inbred.

Peppers.—The performance of the pepper selections was a distinct disappointment this year. A period of extremely hot, dry weather was no doubt responsible for this condition. Growth of the plants was particularly lush but very few fruits set. In fact, only ten plants were selected for saving seed from the year's tests.

Tomatoes.—In further testing of F_1 hybrids, the Red Cloud by Pennheart cross produced a very heavy yield of good quality fruit. The trials once again brought out the fact that there is a tendency for the fruit of F_1 hybrids to be smaller than that of either of the parents. In several hybrids, however, where selection 32-1-2-2 was used as one of the parents, the individual fruit size held up very well.

Several tests using genetic male-sterile lines interplanted among normal tomatoes indicated that bumblebees cross-pollinated tomatoes to a greater extent in some locations than in others. None of the male-sterile lines produced as much seed when handled in this manner as normal plants. Whether this method can be used to produce F_1 seed on a commercial basis is still an open question.

The Culture and Nutrition of Vegetables. (William H. Lachman.) Ten plantings of four varieties of hybrid sweet corn were made at approximately ten-day intervals to determine the relation of heat units to maturity in corn. It was found that 50°F. was the most reliable base temperature to use in order to determine the heat units accumulated from planting to maturity. During the season the number of days required for maturity varied from 55 to 94 for Spancross, 56 to 98 for North Star, 75 to 102 for Carmelcross and 81 to 111 for Golden Cross Bantam. There was a very close relationship between the degree of maturity and accumulated heat units for this crop.

The use of one of the synthetic growth substances, p-chlorophenoxyacetic acid at 30 parts per million definitely stimulated fruit set in Firesteel and Stokesdale tomatoes grown out of doors. In the extra early planting of potted Firesteel tomato plants, however, practically every fruit in the first three pickings developed blossom end rot. This material also set fruit on emasculated blossoms of Red Cloud, Pritchard and Waltham Forcing as well as on functional-sterile John Baer blossoms and on genetic male-sterile blossoms of Earliana.

DEPARTMENT OF POMOLOGY
A. P. French in Charge

Storage Investigations.—F. W. Southwick and E. Cox.) For use during the 1949-50 storage season homemade activated-carbon, air-purification units were built for two commercial apple storages. These units contained horizontal trays approximately 1 inch deep on which an even bed of coconut shell carbon was placed. Carbon was used at the rate of approximately 6 pounds per 1,000 bushels

of fruit. Each unit contained auxiliary fans to provide a positive air flow through the carbon, and the cleansed air was fed into the main blower-type cooling system. At the experiment station comparisons were made of apples held in rooms with manufactured cannisters of activated carbon and activated carbon brominated at 1 and 3 percent levels. In all rooms containing carbon (and comparable control rooms) composite samples of the varieties McIntosh, R. I. Greening, and Cortland were placed. From 12 to 26 days of storage life was added to all varieties wherever carbon was employed. The amount of scald on McIntosh and R. I. Greenings was reduced wherever carbon was used, although in some instances commercial control was not obtained. On these varieties carbon was generally superior to shredded oiled paper for scald control. On Cortland, however, carbon was a failure for scald control. Oiled paper failed to control it, also, but was superior to carbon. It appears that homemade units properly constructed may be as suitable as manufactured air-purifiers. Brominated carbon was not significantly better than unbrominated in its ability to increase the storage life of apples or to reduce susceptibility to scald.

Respiration studies were continued on tomatoes and apples. Measurements have been made to determine the influence of the hormone parachlorophenoxyacetic acid, which is used for increasing the fruit set of tomatoes, on the rate of respiration and ripening of the fruits. Similarly the influence of naphthaleneacetic acid type materials on apples, which have been treated shortly after calyx for thinning purposes, has been studied. Results are insufficient to allow any conclusions at this time.

Influence of Chemical Treatments on Flowering and Fruiting of Fruit Trees.—(F. W. Southwick and W. D. Weeks.) In the spring of 1949 emphasis was placed upon the use of naphthaleneacetic acid type materials (NAA) for thinning apples after calyx.

During the months from May through August, inclusive, the mean temperature averaged several degrees above the normal. Apples bloomed in early May about 2 weeks earlier than usual. Also, the months of June, July, and August were characterized by extreme drought. Under these conditions NAA materials applied about 2 weeks after calyx caused much more foliage damage than similar treatments applied in 1948. Several treatments distinctly overthinned.

However, promising results were obtained on Early McIntosh, Wealthy, Golden Delicious, and Baldwin by the use of from 20 to 30 p.p.m. of NAA applied approximately 2 weeks after calyx. Similar concentrations on Gravenstein and Red Astrachan failed to reduce the set. Duchess suffered so much foliage injury that the apples failed to develop as good size as those on similar trees hand-thinned several weeks later. Generally, chemically-thinned trees have a smaller total yield than unthinned trees but produce a greater volume of apples 2½ inches and up in diameter. It was found, also, that a commercial formulation of NAA containing a wetting agent caused more foliage damage and thinned to a greater degree than a similar material with no wetting agent. Indications are that naphthaleneacetic acid is as effective as equal concentrations of sodium naphthaleneacetate for thinning.

In the spring of 1950 records obtained from chemically-thinned trees showed that several biennial varieties bloomed sufficiently for a commercial crop in what would normally have been an "off" year. For instance, on some vigorous Baldwin and Early McIntosh trees which were somewhat overthinned in 1949 with NAA sprays applied about 2 weeks after calyx, about 25 percent of the growing points blossomed in 1950. These two varieties are extremely biennial, and it cannot be assumed that such results can be obtained frequently. Golden Delicious

and Wealthy, which are easier to make annual in production by early chemical thinning, have borne successive crops following NAA sprays applied about 2 weeks after calyx.

The Influence of Various Clonal Rootstocks on Apple Varieties. (W. D. Weeks and F. W. Southwick.) Because of light bloom and spring frosts, yields were too small in the main stock and scion orchard to make comparisons for most varieties. However, the crop of Rhode Island Greening was of sufficient size so that the effect of stock on yield could be measured. Trees on Malling XVI were more productive than those on Malling I and V. This difference in yield may be due in part to differences in tree size, as Malling XVI produces a larger tree than I and V.

Trunk circumferences taken from a 12-year-old block of McIntosh in a cooperative orchard indicate that trees on seedling roots are larger than trees on Malling XV, X, and XIII. The average trunk circumferences for McIntosh on seedling roots was 640 mm. Average trunk circumferences for trees on Malling XV, X, and XIII were 560, 533, and 489 mm.

An interesting observation was made in a cooperative orchard at Sterling on the effect of stocks on susceptibility to winter injury. Trunk injury to Baldwin trees on Malling IV was practically complete in that the bark had separated from the wood around the entire circumference of the tree trunk. Alternate Baldwin trees in the same row on Malling V showed no evidence of any injury whatever. Similar injury was observed with Red Spy and McIntosh on Malling IV but to a lesser degree. While Malling IV has been discarded because it makes a weak graft union, its susceptibility to winter injury gives another reason why it should be discarded as a rootstock for apples.

Study of Bud Sports of the McIntosh Apple. (W. D. Weeks and F. W. Southwick.) The amount and type of red color was determined for each of the seven strains involved in the test. Rogers continued to have the largest percentage of highly colored fruit. It also continued to be the only strain which did not have some striped fruit. The relative rank of the other strains was the same as the previous year. Preharvest drop records were obtained for each of the seven strains, but there were no significant differences among strains.

From the performance of the past two seasons Rogers appears to be a superior strain with respect to amount and type of red color.

The Nutrition of Apple Trees. (In cooperation with Chemistry and Agronomy.) (W. D. Weeks, F. W. Southwick, Mack Drake, Dale Sieling.) Because of the large reserve of nutrients carried over by the trees from the 1948 season, differences due to 1949 treatments were not significant. Measurements of fruit set, size, color, and yield were taken from the different plot treatments. Leaf samples were taken and analyzed for nitrogen, potassium, phosphorus, calcium, and magnesium. A comparison of the nitrogen content of 1948 leaves with that of 1949 leaves showed a slight decrease in nitrogen content as the rate of hay mulch was increased. Where 2 pounds of nitrogen were applied per tree there was a slight increase in leaf nitrogen.

Although no measurements are available for the 1950 season, observations of the trees receiving mulch indicate that they have a lower leaf nitrogen content as evidenced by their pale green foliage.

The Nature of Winter Hardiness in the Raspberry. (J. S. Bailey and F. W. Southwick.) At about monthly intervals through the winter determinations were made of the respiration rate of the canes of two red raspberry varieties:

Washington, a relatively tender variety; and Chief, a hardy variety. At the same time canes were placed in the greenhouse in water to check on the ending of the rest period and winter injury, if any. There appeared to be a slight decrease in the initial respiratory rate and a slight change in the slope of the respiratory curve at the time the rest period ended early in January.

Of the canes brought in March 20, those of Washington looked dry, as if they had been injured. Forcing in the greenhouse showed that the tip half of most of the Washington canes was dead. The Chief canes showed little or no injury. The respiration rate of the injured Washington canes was lower than that of the uninjured Chief canes.

Blueberry Culture. (J. S. Bailey.) In cooperation with Dr. F. R. Shaw of the Entomology Department, a study of the effects of DDT on bees was continued in the spring of 1949. A large colony of bees was placed in the Station blueberry field which was dusted twice with DDT. Applications were thorough and no attempt was made to avoid dusting bees or hive. Careful observation immediately after dusting revealed no evidence that DDT acts as a repellent as some have thought. In half an hour both honey and bumble bees were working blossoms. The weight of the hive decreased slightly for two days and then came back to the previous weight, indicating only slight and temporary injury to the colony. A report of this investigation appeared in the 1949 volume of Gleanings in Bee Culture.

In 1950, two colonies were exposed to (1) a 5 percent methoxychlor dust and (2) to a spray containing 3 pounds wettable methoxychlor in 100 gallons of water. A slight decrease in colony weight followed the application of the dust. However, at the end of the experiment the colonies had gained 3.25 and 6 pounds in weight. The results of these experiments will appear in the 1950 American Bee Journal.

Observations were continued on the new blueberry selections from the U. S. Department of Agriculture. A late frost gave opportunity to learn something of their frost resistance. This is reported in the variety project. Publication: Frost Injury to Blueberries by John S. Bailey: Fruit Varieties and Horticultural Digest 4(4):98. 1949.

Further checking on the blueberry stunt disease revealed only three or four new cases in the Cape Cod area. One nursery is reported to be importing stock from New Jersey where the stunt disease is very serious. Such a situation needs careful watching.

Publications: Blueberry Varieties for Massachusetts. John S. Bailey. Fruit Varieties and Horticultural Digest 4(4):91-93. 1949. It's Time You Had Blueberries In Your Garden. John S. Bailey. Popular Gardening 1(1):36-37, 63-65. 1950.

Nutrition of the High-Bush Blueberry, Especially in Relation to Soil Reaction. (J. S. Bailey and Mack Drake.) Again in 1949 some plants in the Station planting showed a type of chlorosis thought to be due to a lack of iron. An attempt was made to supply iron by dipping the ends of shoots in a 10 percent ferrous ammonium sulfate solution. The solution entered the leaves as shown by injury, even to leaves of adjacent shoots, but no greening resulted. Pad and thread injections of ferrous sulfate were tried also, but no greening resulted. These trials were made in early August which may be too late for greening.

In the late summer of 1949 a blueberry planting in Middleboro, Mass., showed signs of severe magnesium deficiency. A series of plots was laid out in triplicate. The treatments are check, $MgSO_4$, 150, 300, 600, and 900 pounds per acre, and dolomitic limestone at the rate of 500, 1,000, 2,000, and 3,000 pounds per acre.

Before the treatments were applied leaf samples were obtained from each plot. Chemical analysis showed the Mg content of the leaves to be extremely low. The highest value was 0.078 percent and the lowest 0.030 percent.

Improvement of the Wild Low-Bush Blueberry. (J. S. Bailey, W. D. Weeks, C. E. Cross, and F. R. Shaw.)

Insect Pests.—Through the cooperation of the Entomology Department, a graduate student, Thomas Loeber, was assigned to work on the insect problems of the low-bush blueberry. A report of his work follows:

1. Investigations of the seasonal history of the blueberry flea beetle.—In 1949, the hatching of eggs must have occurred about April 20 since young larvae were found in the field on April 25. The larvae fed for 12-14 days, spent 7 days as prepupae and 11.5 days as pupae. The first adult appeared on May 21. The seasonal history as observed in 1949 was approximately 3 weeks earlier than in 1948.

2. Control of the blueberry flea beetle.—Parathion, DDT, and lead arsenate were tested for control of this pest. Parathion proved effective both as a dust and spray against the feeding stages of the insect. DDT dust was inferior to an 85-15 lead arsenate–sulfur dust against late larval instars.

Publication: The Blueberry Flea Beetle. F. W. Shaw, J. S. Bailey and E. H. Wheeler. To appear in the Jour. of Econ. Ent.

3. Survey of insects of low-bush blueberry.—Some 35 species of insects were found injuring the low-bush blueberry. The blueberry flea beetle and blueberry maggot were most abundant. Several species of Lepidoptera, mainly Geometridae, were recorded. The following were most abundant: *Abbotana clemataria*, S. & A., *Glena cognataria* Hbn., and *Itame inceptaria*, Walker.

A large green stink bug, *Chlorochroa uhleri* Stal., was common and when confined in a box of blueberries contaminated the entire box.

Clastoptera proteus Fitch, the cranberry spittle bug, was present in moderate numbers from midsummer until fall.

Two blossom weevils, *Anthonomus musculus* Say and *A. rubidus* Lec., were fairly abundant. A small click beetle, *Cardiophorus convexulus* Lec., was present in large numbers throughout the season.

Further studies of the development and control of the blueberry flea beetle are in progress under the supervision of John Weidhaas. Life history studies indicate that, as in Maine, the insect passes the winter as an egg. Thorough burning eliminates the eggs and it is believed that reinfestation occurs primarily by the spread of beetles from improperly burned areas. A number of insecticides are being tested against both larval and adult stages. Of these, DDT, parathion and methoxychlor seem most promising.

Weed Control.—Kerosene at 2, 3, and 4 gallons per square rod and Stoddard Solvent at 1, 1½ ,and 2 gallons per square rod were tried on four different dates from early to late April. Kerosene had little effect on either weeds or blueberries. Stoddard Solvent had little effect on weeds and proved somewhat toxic to blueberries.

Borax at 3, 6, and 9 pounds per square rod, applied in April, was very toxic to all plants including the blueberries. However, there were some signs in the fall that the blueberries might be coming back on the plots with the 3 and 6 pound applications. The last of August another series of plots was laid out using borax at ½, 1, 2, and 3 pounds per square rod. Also, spot treatments were tried on a number of species using ¼ cup of borax per clump.

A comparison was made of the ammonium and sodium salts of 2,4-D at 250, 333, and 500 p.p.m. for the control of sweet fern. These salts appeared to be

equally effective in controlling sweet fern, and neither caused any observable injury to the blueberries. However, the 250 and 333 p.p.m. concentrations were too low to give good control, but 500 p.p.m. appeared effective.

The ammonium and sodium salts and two esters of 2,4-D and two esters of 2,4,5-T at 250, 333, and 500 p.p.m. were compared for the control of bayberry. Esteron 245, an ester of 2,4,5-T, appeared to be the most effective. Practically all tops were killed at 333 and 500 p.p.m. Some resprouting occurred in the spring of 1950.

In June a mixture of Dow Contact Herbicide (13 ounces) and kerosene (to make 1 gallon) was sprayed on the base of the trunks of poplars 2-5 feet high. The tops appeared to be killed but there was some evidence of resprouting late in the season. Painting this material on the trunks was not effective.

In September a number of species were treated with an ester of 2,4,5-T and a mixture of equal parts of an ester of 2,4-D and an ester of 2,4,5-T at 2500 p.p.m., also a GLF weedkiller (a mixture of 2,4-D and 2,4,5-T) at 1:40 as recommended by the manufacturer. All of these treatments killed gray birch.

Chemical Control of Weeds in Fruit Plantings. (J. S. Bailey.)

Strawberries.—A series of plots in triplicate were treated with the sodium salt 2,4-D at ¼, ½, ¾, and 1 pound per acre 11 days after the plants were set. The ¼, ½, and ¾ pound treatments controlled broad-leaved weeds for three to four weeks and retarded the growth of grasses. One pound per acre held broad-leaved weeds for about six weeks. There was some evidence of slightly reduced growth resulting from the 2,4-D treatments, particularly the two heavier ones. The ¼, ½, and ¾ pound per acre plots were re-treated 25 days after the first treatments. Broad-leaved weeds were held fairly well until June 20. Two applications at ½ or ¾ pound per acre appeared slightly better than one application at 1 pound per acre. All plots were cultivated from June 20 to July 23 when the 2,4-D plots were re-treated. Weed counts made September 6 showed no reduction in number of weeds but there was a reduction in size of weeds, both broad-leaved and grasses.

On May 10 three plots were sprayed with Stoddard Solvent. The strawberry plants were protected by covering them with No. 10 cans. It gave good control of both broad-leaved weeds and grasses until June 20.

Sodium trichloroacetate at 10 pounds per acre gave good control of grasses but was too toxic to the strawberries.

Sodium pentachlorophenate at 10, 17.5, and 25 pounds per acre was tried as a preplanting treatment. Weeds were checked for 3 to 5 weeks. Strawberry plants showed chlorosis, particularly at 25 pounds per acre, which they outgrew later in the season. There was reduced growth of strawberries at 25 pounds per acre.

Pentachlorophenol in oil at 7, 10, and 13 pounds per acre was tried as a pre-planting treatment, both before and after weed emergence. Post-emergence treatments were the most effective but this necessitated delay in the planting of the strawberries which is undesirable. Fuel oil alone appeared to be as effective as oil plus pentachlorophenol.

Isopropylphenylcarbamate at 10 pounds per acre applied in late October controlled chickweed but caused some injury to Catskill and severe injury to Howard strawberries. Applied in May at 10, 15, and 20 pounds per acre, it caused a chlorosis of the leaves and stunting of the plants which increased with increasing rate of application. There were varietal differences: Sparkle was affected the least and was nearly as good as the checks; Catskill, Robinson, Howard, and

Temple were about alike and much more affected than Sparkle; Wm. Belt was worst.

Raspberries.—Since sodium trichloroacetate applied in August caused a severe chlorosis and curling of raspberry leaves, another series of plots was laid out in November and treated at 20, 40, 60, and 80 pounds per acre. The 80-pound application reduced the quack grass stand by only 30 percent.

A small plot sprayed with Stoddard Solvent in June and August indicated that this material may have a place in weed control in raspberries.

Blueberries.—Sodium trichloroacetate applied in August, 1948, at 150 pounds per acre killed 75 percent of the bushes. Although applications at the rate of 37.5, 75, and 112.5 pounds per acre caused delayed foliation and chlorosis in 1949, the bushes have recovered and appear to be in good condition but their crop is light. Blueberry bushes in plots treated with sodium trichloroacetate in November, 1949, show chlorosis varying from slight at 12.5 pounds per acre to severe at 100 pounds per acre. TCA at 100 pounds per acre reduced the quack grass stand by about one half; 50 pounds or less gave little or no reduction in stand.

An application of Dow General (dinitro-ortho-secondary-butylphenol) was made in May at a rate to give 14-15 pounds of actual toxicant per acre, which is a very heavy rate. The leaves looked rather yellow and sickly for a couple of weeks but the bushes outgrew the injury and bore a good crop. This indicates that any reasonable application (around 3 pounds per acre) would be safe. Since this is a contact killer, it is effective against annual weeds but not against perennials like quack grass.

Apples.—A small block of apple trees on Malling 9 stocks was suffering from severe competition from a tough sod of creeping red fescue. Half the block was cultivated and half used to see if the sod could be suppressed by sodium trichloroacetate. Treatments were made May 2 at 0, 10, 20, and 40 pounds per acre. The trees were ring-fertilized. Where the fertilizier was applied it counteracted the effects of the TCA. The TCA, even at the lowest rate, caused a chlorosis of the leaves. The trees in the cultivated plot look much better and made better growth than those in any of the treated plots.

On November 5, 1945, TCA was applied around the trees in a young apple orchard at 50, 100, and 150 pounds per acre. No reduction in quack grass stand resulted from the 50 pound application; 100 or 150 pounds per acre reduced it 2/3 to 3/4.

Peaches.—Chemical "mowing" was tried in a contour peach orchard where the berms are covered by a tough quack-grass sod. A mixture consisting of Dow General (dinitro-ortho-secondary-butylphenol) 5 quarts, fuel oil 60 gallons, and water to make 400 gallons was used at the rate of about 200 gallons per acre. Three applications were made, one in late April, one in mid-May, and one in early July. The quack grass was killed to the ground but came back in about 3 or 4 weeks. Chemical "mowing" is faster than hand mowing. Two men with a power sprayer covered the orchard in half a day. It takes two men 4 or 5 days to do it by hand. However, if the grass is allowed to grow until the stems become tall and woody, they are left standing by the chemical and not only puncture dropped fruit but also are somewhat of a fire hazard. Therefore, to do a good job, chemical should be applied several times during the season, before the grass gets too tall.

Studies of Varieties of Fruits. (W. D. Weeks and Staff.)

Apples.—Idared, a recent introduction from Idaho, fruited for the first time. It shows some promise as a winter apple, characterized by large size, high color, and good quality.

Davey revealed a rather serious weakness during the 1949 season in its tendency to crack. This trouble may be due to the hot dry season, but it must be taken into consideration in the final evaluation of the variety.

Blueberries.—Kenlate was imported from Nova Scotia, Canada, because it was supposed to be unusually late. The bush is small and dwarfish and although it bears a good crop for the size of the bush, the bush is too small to be a very heavy yielder. The fruit is only medium in size, fair in flavor, a little dark in color, and is not as late as was first supposed. It ripens ahead of such late varieties as Rubel and Jersey. It is probably of little use in this State.

Berkeley is a new variety which was named less than a year ago. The bush appears to be vigorous and productive: the fruit is exceptionally large, is an excellent blue color, and is very attractive, but the flavor is a bit mild. It ripens in mid-season with Concord and Pioneer.

Coville is another new variety named at the same time as Berkeley. The bush appears to be very vigorous and very productive. The fruit is large but not as large as that of Berkeley; it does not have such a light blue color but is very fine in flavor. It ripens late and looks like a promising variety.

Raspberries.—Some two hundred raspberry seedlings which were obtained from the New York Agricultural Experiment Station at Geneva, N. Y., fruited for the first time. Preliminary examination, based on size and quality, revealed several seedlings which are promising enough for further trial.

Strawberries.—Sioux appears to be a rather weak grower and not too good a plant maker. It ripens in mid-season. The fruits are rather small, lacking in flavor, and production was light. It does not look promising.

Robinson appears to be somewhat above medium in vigor and a fairly good plant maker. The fruits are medium to large in size, regular in shape, color evenly, and are attractive. However, the flavor is rather flat and insipid. It is noteworthy that June yellows appeared in this variety this year. The chief things to commend this variety are its plant-making ability and the fine appearance of the fruit.

Valentine. Plants of this variety are very vigorous and good plant makers. Fruit stems are long, thick, and erect so that they hold the fruits up well. The fruit ripens a little after midseason, is medium to large in size, regular, attractive, not too dark in color, firm, juicy, and of very good quality. It looks very promising.

Great Bay is a vigorous growing variety and good plant maker. The fruit stems are long, thick, and erect. The fruit matures late and is large and firm but is variable, irregular, and not very attractive. The berries are rather tender and juicy, a bit sour, and lacking in strawberry flavor. Some fruit rot was noted before the berries were ripe. Lateness seems to be the only outstanding characteristic of this variety.

Van Rouge. Plants of this variety are only medium in vigor although good plant makers but not too productive. The fruit matures in midseason, is small to medium in size, rather dark and unattractive; the flesh is firm and juicy but sour. The flavor is poor. The berries separate too easily from the stem. This variety does not look promising.

Fairpeake was very disappointing this season. The plants showed only medium vigor although fairly good plant makers and production was rather light. The fruit ripens late, is medium to small in size and rather variable, irregular, and unattractive with hard, undeveloped tips. The flesh was firm but rather dry, sour, and lacking in flavor.

Redcrop was also rather disappointing. The plants were only medium in vigor and not too good plant makers. The production was rather light. The stems were rather short and a bit slender so that the berries were on the ground. The fruit matured late and was rather small and variable in size although fairly attractive in appearance. The flesh is firm and juicy but rather sour and only fair in flavor.

Black. Plants of this variety are only medium in vigor but are good plant makers. Production was about medium. The fruit matures late and is large to medium but somewhat variable in size. It colors evenly and is very attractive in appearance. The flesh is firm and juicy although a little stringy, sweet and subacid, mild and agreeable in flavor. It seems worthy of further trial.

Superfection. Plants of this variety are rather weak and dwarfish but fairly good plant makers for an everbearer. Production appears to be light. The fruit is small and uniform in size and regular in shape. The berries color evenly, are medium red and attractive. However, the flesh is tender and juicy and very sour and poor in flavor. It does not look promising.

Brunes Marvel is another everbearer which is only medium in vigor and rather dwarfish in habit. It is a poor plant maker and production is light. The fruit is only medium and variable in size, regular in shape and attractive. The flesh is tender, rather dry, a bit sour and only fair in flavor. It does not look promising.

Elgin. Plants of this variety appear rather weak and dwarfish although good plant-makers. Production was only medium. It appears to be quite susceptible to leaf spot. The fruit matures very late, being one of the last berries to ripen. The fruit is large, uniform in size but irregular in shape, rather rough and not too attractive. The flesh is tender, a bit dry and sour with very poor flavor. Lateness is the only thing to recommend this variety.

Fairland is a very streng grower, an excellent plant maker and very productive. The fruit matures in early midseason, is large and uniform in size and regular in shape. The berries are very attractive, the flesh is very firm, juicy, and of fairly good quality although it is a little mild in flavor. It looks very promising.

Peaches.—Erly-Red-Fre is an unusually promising early peach. The fruit is medium to large in size, very well colored, and very attractive. The flesh is white, firm and has very good flavor for an early peach. It has a slight tendency to cling to the pit. This is the best early peach tried so far.

Fowler is a late peach, ripening with or a little ahead of Elberta. The trees are very vigorous but so far the crops have been very light. The fruit is yellow fleshed, large, round, attractive, well colored, firm, and freestone. The skin is rather thick and tough. It should be a good shipper. The flavor is fairly good. This variety deserves further trial.

Michigold. The tree is moderately vigorous and appears to be a heavy producer. The fruit ripens in late midseason, is large, attractive, yellow fleshed, and well colored. It is freestone with firm flesh but only fair quality. It deserves further trial.

Study of Tree Characters of Fruit Varieties. (W. D. Weeks, A. P. French, O. C. Roberts.) Buds of the Orient pear, a new introduction from Tennessee, were budded to obtain vegetative characters for nursery identification work. Orient

has some resemblance to Kieffer but differs from Kieffer by having fewer and larger lenticels which are russet instead of white. The growing tips of Orient are redder than Kieffer. Orient has a smaller and less folded leaf blade with an acuminate tip. The net veins are slightly raised, while those of Kieffer are depressed. Serrations are more prominent and sharper.

Field inspection of fruit tree nurseries for trueness-to-name was extended to Iowa and Missouri during the year. While the numbers of misnamed trees found were generally small, some sizable mixtures were found which could have resulted in serious loss to the nurserymen and grower if they had not been detected.

DEPARTMENT OF POULTRY HUSBANDRY
Fred P. Jeffrey in Charge

Broodiness in Poultry. (F. A. Hays.) The broody instinct is of significant economic importance because broody periods are accompanied by a cessation of laying. In Rhode Island Reds bred for high fecundity this nonproductive period has averaged about 15 days for many generations. The increased incidence of broodiness in many crosses of strains and breeds has been observed by many workers. So far as we are aware, a completely non-broody line in any breed has never been established.

In this experiment selection of breeding stock is being made on the progeny test and on the reaction of each female to the prolactin hormone. The generation hatched in 1948 completed the first laying year with no evidence of broodiness. It is well known, however, that the instinct may be deferred to the second or third laying year, so that further tests are necessary and are being carried on. If the broody instinct can be completely eliminated by breeding methods, there would be an answer to an important economic problem.

Genetic Laws Governing the Inheritance of High Fecundity in Domestic Fowl. (F. A. Hays and E. W. Spear.) The many individual characters and factors that regulate egg production are being studied in a closed flock of pedigreed Rhode Island Reds. Inbreeding has been constantly avoided so that the degree of inbreeding amounts to about 5 percent, or below the estimate for random matings. Viability in the stock is being given constant attention together with a long series of other desirable characters.

Particular attention is now being directed toward reducing the variability in rate of laying. A study covering ten generations shows clearly that winter pause and winter intensity are intimately associated and that very high intensity tends to reduce the pause incidence and duration. Winter pause incidence shows a low degree of heritability, but pause duration has a much higher degree of heritability.

In the generation hatched in 1950, an intimate association appeared between hatchability and sex ratio of chicks. Hens that hatched from 90 to 100 percent of fertile eggs had 49 percent males at 8 weeks, compared with 55 percent males from hens with hatchability of 60 to 69 percent. This means that female embryos are less viable than male. Families of chicks with a high percentage of males were more viable to 8 weeks of age but this higher viability did not persist for the period from 8 weeks to 6 months or for the first laying year. There is evidence that significant progress can be made in raising the production level well above the present level of 232 eggs.

A Study of Fertility Cycles in Males. (F. A. Hays and E. W. Spear.) Definite evidence has been produced indicating that fertility is regulated by genes

transmitted from sire to daughter. Sires may be selected for high fertility either on the basis of the records they make with their mates or on the performance of their daughters. A recent study has shown that in natural matings some males fail to mate often enough with certain hens to insure a supply of fresh spermatozoa. The result is an abnormal increase in early embryonic deaths through the breeding season in some females.

Artificial light supplied at the rate of about 2 foot-candles on the floor has been more effective and more economical than sex hormones for activating old males.

A significant correlation between fertility and hatchability has appeared in recent generations. This association is believed to be produced by stale sperm

Secondary and Adult Sex Ratio in Relation to Hatchability. (F. A. Hays.) One line of Rhode Island Reds has been established that shows a mean hatchability of about 40 percent. A second line has been developed for high hatchability. There is a significant difference in the hatchability of these two lines. Particular attention is being devoted to the specific causes of low hatchability.

Females with highest hatchability give the lowest percentage of males because the female embryos are less viable than the male. When hatchability exceeds 90 percent, fewer males than females appear in the family.

Under our condition of incubation, early embryonic deaths tend to increase slightly through the March and April hatching period. Evidence indicates that this increase is due to infrequent matings between some birds and not to incubation conditions.

The Development of Inbred Lines of White Plymouth Rocks. (F. P. Jeffrey and J. Robert Smyth, Jr.) Fourteen inbred lines of White Plymouth Rocks are being developed. During the first year of brother x sister matings the hatchability of total eggs set was 60 percent as compared to 77 percent in the random-bred flock of White Plymouth Rocks. During the 1950 brooding season all inbred chicks received heavy exposure to bronchitis and an unknown "respiratory disease." Six-week mortality among sire progenies ranged from 29 to 66 percent. Only one family showed 100 percent livability, whereas six families had mortality exceeding 90 percent.

Genetics and Physiology of the Length of Incubation Period in the Domestic Fowl. (J. Robert Smyth, Jr.) Observations were made on the emergence time of White Plymouth Rock chicks at six-hour intervals during the twentieth, twenty-first, and twenty-second days following the start of incubation. These observations were made on the offspring from three single male matings and the chicks were pedigreed and raised for observation and future breeding stock. Divergent lines in respect to emergence time will be developed for future study by mating the early hatching with early hatching individuals and late hatching with late hatching individuals.

The average emergence time of the present generation was 21 days and 19 hours after the eggs were set in the incubator. The chicks hatched over a period of 48 hours beginning at 20 days and 18 hours and ending at 22 days and 18 hours. Chicks hatching during the first third of this period represented 12.3 percent of the total while 69.8 percent emerged during the middle third and 17.9 percent during the last third.

No significant correlation was found between the time of emergence and the sex of the chick or between livability to five months of age and emergence time, although the early emerging chicks showed a slightly higher percentage of livability. The exposure of this stock while very young to a chronic respiratory

disease and the resulting mortality could have masked any inherent differences between the early and late emerging groups in resisting causes of death normally encountered.

Although male families showed no statistically significant differences for emergence time, dam families showed highly significant differences. The average emergence time for dam families ranged from 21 days and 9 hours to 22 days and 4 hours after the onset of incubation.

The Effect of Sperm Survival Time in the Female Reproductive Tract on Fertility and Hatchability in the Fowl. (J. Robert Smyth, Jr.) Observations are still being made on the sperm survival time in the oviduct of the fowl for six White Plymouth Rock males, each of which is being mated to the same 60 White Plymouth Rock females. The offspring are being individually pedigreed on the basis of both sire and dam and the age of the fertilizing sperm cell. These pedigreed chicks will form the foundation stock for the study in 1951. At the present time the data collected are not complete enough to warrant any conclusions.

SEED CONTROL
Frederick A. McLaughlin in Charge

Enforcement of the Seed Law, together with the desire of seedsmen to comply with requirements of this Act, and a growing interest of the public in good seed, resulted in a large number of service samples being sent to the Seed Laboratory for testing. From July 1, 1949, to June 30, 1950, 6151 service and inspection samples of seed were received and worked at the laboratory. The laboratory also received and cleaned 78 lots of tobacco seed.

Analysis of inspection samples shows that most seedsmen have complied with label requirements of the Seed Law. A large part of the violations found are technical in nature rather than flagrant.

Operation of the Seed Law is reported in an annual bulletin issued for that purpose.

SHADE TREE LABORATORIES
Malcolm A. McKenzie in Charge

Diseases of Trees in Massachusetts. (M. A. McKenzie, A. Vincent Osmun, and D. H. Marsden.)

Dutch Elm Disease. From July 1, 1949, to June 22, 1950, the Dutch elm disease was found in 49 additional towns, making a cumulative total of 183 since the disease was first known here (1941, Alford, Berkshire County). Summarily, in laboratory studies by means of tissue plantings in artificial culture media, the disease fungus, *Ceratostomella ulmi* (Schwarz) Buisman, has been isolated from 6498 trees in 11 of the 12 counties on the mainland, Barnstable, Dukes, and Nantucket being reported disease-free at present.

Current investigations indicate the importance of completion of adequate sanitary operations promptly. Delay in removing and burning diseased trees may result in expanding disease spread and costs of control. The use of spray materials to restrict vectors of the disease fungus may be a valuable adjunct to Dutch elm disease control by sanitation methods. Studies to this end are in progress in cooperative investigations with the Department of Entomology.

Study of disease resistance in elms offers another challenge to the spread of the disease. But reliance should not be placed in propagation from a single disease-

resistant tree. Such progeny may not constitute a permanent answer for satisfactory shade trees. Diseases previously known to cause only slight damage may become serious with the test of time. Also, disease-producing organisms themselves may undergo parallel readjustment and survive as parasites of changing host.

Popular opinion relative to the significance of the disease has ranged from complete indifference to utter despair. Both extremes are at variance with known facts relative to the disease and could nullify, in part at least, constructive efforts for restricting disease spread and checking the decimation of American Elms, as inherent and congruous in the New England scene as the familiar village greens of which they may be a part.

To wishful thinkers who rationalize blindly "There is no such thing as Dutch elm disease," stark tree skeletons and barrenness are undeniable refutations evident in casual observation not far beyond State boundaries of the Commonwealth. Massachusetts cherishes her elms far beyond any monetary estimate which might be placed upon them, but some idea of the investment in dollars may help all of her citizens to appreciate more fully the true worth of her principal shade tree. In a recent elm census report, the value estimated for the elms in four Massachusetts cities and towns was conservatively placed at $7,300,000.

To mournful fatalists who decry elm extinction as inevitable, a critical review of the situation throughout Massachusetts should abate considerably the panic of frustration.

Studies of conditions throughout the State indicate that some towns where elms occur almost exclusively as cared-for shade trees can, with proper consideration to ordinary maintenance, avoid extensive loss of elms. In such areas, living with the Dutch elm disease should not involve losses much in excess of losses already known in connection with native tree diseases.

For communities where a large percentage of the elms are wild trees, in such favorable elm sites as Housatonic, Connecticut, and Merrimac Valleys, further study is needed to achieve a satisfactory balance for living with the disease.

In the meantime, restricting the extensive planting of elms, except where conditions are favorable locally, may be a basis for utilizing more fully other suitable plant materials in new real-estate developments and otherwise. The dangers of planting exclusively a single species or variety of tree should be apparent from familiar local and world-wide tragic experience with the Dutch elm disease.

Nine progress reports (mimeographed) and nine press releases were sent out during the year.

Tree Problems in New Highway and Real-Estate Developments. Increased activity in construction of buildings, walks, highways, and related accommodations has created a variety of tree-maintenance problems. In some communities serious tree losses are inevitable in current highway and other construction. Necessary as these operations may be, losses often represent irreplaceable trees and no alternative for the tree cutting or damage should be discarded without exhaustive consideration. Trees are valuable citizens and constitute an important part of taxable property. When the number of trees cut in a community exceeds the number of trees planted, the community faces a disaster of considerable significance. Trees in many towns may be the common denominator of all generations, and they can make the difference between mediocrity and superiority. They are often the only beauty in an otherwise dismal setting.

Investigations have shown wide variations in specific causes for disorders of trees involved in construction operations, and case histories indicate that condi-

tions are often peculiar to individual sites. To this extent each tree is unique, but problems encountered most commonly under general and particular conditions are:

1. Failure of trees already established previous to construction work.
2. Failure of trees planted following construction work.
3. Failure of single trees left when most trees are cleared from an area.
4. Mechanical injury to tree roots.
5. Mutilation by construction machinery or operations.
6. Trees not suited to small space allotted in crowded multi-unit real-estate developments.
7. Poor drainage.
8. Improper use of fill about tree trunks.
9. Significant rise or fall in water table.
10. Frost cracks.
11. Slime flux.
12. Drought.
13. Winter injury.
14. Lightning.
15. Illuminating gas in soil from break in gas main.
16. Fire scars from burning rubbish near by.
17. Pests emanating from accumulation of cut trees.

Other Tree Problems. Forty-three diseases of twenty-eight species of trees including nine diseases of elms were identified from more than 1250 specimens and inquiries during the year. Wilt diseases of elm which under certain conditions may be confused with Dutch elm disease, have been found widely throughout the State, especially in association with the fungi *Cephalosporium* sp. and *Verticillium* sp. The latter fungus has also been isolated frequently from other diseased woody plants concerning which correspondents have requested information.

Extended periods of dry weather resulted in direct injury to certain plants and also contributed to damage by fungi and insects, notably on evergreens.

A disease of mockorange (*Philadelphus* spp.) continues to attract wide attention throughout Massachusetts. No part of the State appears free from the trouble which is most conspicuous as unsightly dead stalks on older shrubs. Appearance of affected plants suggests that a pathogenic organism is the cause of the trouble, but none has been identified as yet.

The disease of maples in which bronzed flags develop from foliage on maples was not so much in evidence during the past year. Wet weather is thought to favor its development and dry weather may have restricted it.

Widespread inquiries have been received relative to a disease of oaks reported to be caused by the fungus *Chalara quercina* in certain midwestern states, but the fungus has not been isolated in laboratory studies here. The cause for death of oaks in Massachusetts, reported to be increasing, has not been determined or investigated.

DEPARTMENT OF VETERINARY SCIENCE
J. B. Lentz in Charge

Poultry Disease Control Service. (H. Van Roekel, K. L. Bullis, G. H. Snoeyenbos, O. S. Flint, M. K. Clarke, O. M. Olesiuk, A. M. Crotty, and C. D. Brandt.)

1. *Pullorum Disease Eradication.*—A total of 579 chicken, turkey, pheasant, and quail flocks was tested during the 1949-50 testing season. The number of

samples tested was the largest currently on record in the testing history for Massachusetts (1,444,364 chicken and 30,840 fowl other than chicken). The percentage of reactors (0.06) was slightly higher than that of the previous season. The percentage of "breaks" (4.82) also was higher. However, 98.20 percent of all birds tested were in 100 percent tested, non-reacting flocks. Ten flocks were classified as infected at the close of the season.

A more detailed discussion of the pullorum testing work is given in the Thirtieth Annual Report of Pullorum Disease Eradication in Massachusetts.

2. *Salmonella Pullorum Studies.*—Antigen variation in *S. pullorum* chiefly involves the XII_2 and XII_3 antigens. The IX and XII antigens are relatively constant. A standard form culture contains a strong XII_3 and a weak XII_2 component. Essentially the opposite exists in variant forms. Some infected birds produce diagnostic levels of circulating agglutinins to only the XII_2 or XII_3 antigen. For this reason an infected bird may react only with antigens of similar antigenic structure. This fact is of marked significance to a control laboratory and is the justification for the investigational work being done on this problem.

Work has been continued during the year to determine the extent and importance of antigenic variation in relation to control testing methods. As was done last year, all cultures isolated at this Station have been comprehensively studied in relation to their antigenic composition. Of a total of 249 cultures isolated from 40 flocks, only 25 cultures from 3 flocks were found to be variants. Two of these three infections were in chicks purchased out-of-State and the third was an infection thought to originate from stock that did not have a pullorum-clean rating.

Although the antigen now in use occasionally fails to detect an infected bird, its over-all efficiency under our conditions is considered to be satisfactory and actually superior in application to any variant-containing antigen now in use. This conclusion has been reached after making over 25,000 tests in the past year with various experimental antigens in duplicate with our routine antigen.

3. *Diagnostic Service.*—During the 1949 calendar year, 7,096 specimens were received in 1,518 consignments of which 1,038 were delivered in person. This represents nearly a 50 percent increase over any previous year and reflects the increased interest in and incidence of respiratory infections, which will be discussed further in another section of this report. The specimens received were classified as follows: 6,475 chickens, 516 turkeys, 20 pheasants, 15 chinchillas, 12 chicken eggs, 10 mink, 9 ducks, 7 pigeons, 6 swine, 5 each of canine feces and bovine, 3 quail, 2 each of deer, finches, geese, and ruffed grouse, and 1 each of canine blood, owl, pea fowl, rabbit, and wildcat.

Fowl paralysis was diagnosed in nearly twice as many instances as in the previous year, but this was not taken as an indication of a true increase in the incidence of the disease.

Sulfaquinoxaline was available for continuous low-level feeding as an aid in preventing coccidiosis and was widely used during the year. There were nearly as many diagnoses of coccidiosis as in previous years, but the outbreaks were modified in character and were milder.

Keratoconjunctivitis—a newly reported disturbance during the past few years and still believed due to litter and ventilation conditions, with particular reference to ammonia fumes—was identified more frequently than formerly.

There were 44 diagnoses of fowl typhoid and 21 of fowl cholera, 35 and 14, respectively, representing new known foci of infection. The incidence of both diseases was higher, but the fowl typhoid was of particular concern, as more than twice as many cases were identified and four communities sustained outbreaks

which involved several neighboring farms. An outbreak of fowl cholera in pheasants apparently was successfully eradicated through depopulation. Avian tuberculosis was identified in two flocks.

Fifteen chinchillas were examined, but a satisfactory herd diagnosis was not made. The larval stage of the dog tapeworm, *Multiceps serialis* (identified by the Zoological Division, B.A.I., U.S.D.A.) was found in a three-year-old female chinchilla. *Dirofilaria immitis* was found in one dog.

The 516 turkeys were received in 92 consignments. Pullorum disease was identified once and paratyphoid twice. In contrast, there were three diagnoses of fowl cholera and six of fowl typhoid. Newcastle disease was recognized in four cases. The effect on egg production was not as marked as in most outbreaks in chickens. There were no outbreaks in very young poults, and mortality was not severe. *Aspergillus fumigatus* was recovered from the cerebrums of poults in one case which showed incoordination suggestive of Newcastle disease. For the fourth consecutive year, fowl pox in turkeys was not brought to the attention of the laboratory.

4. *Flock Mortality Studies.*—Up to January 1, 1950, necropsies were performed on 231 birds (197 females and 34 males) from the flock hatched in 1948 and maintained for genetic studies by the Poultry Department of the Experiment Station. Reproductive disorders (57), cannibalism (34), injury (34), alimentary disorders (30), and kidney disorders (24) were the most common diagnoses. The population had a relatively low incidence of tumors—leiomyoma (5), lymphocytoma (5), myelocytoma (1), hemangioma (1), and fowl paralysis (5). Hjörre's disease (coli-granuloma) has been recognized in from one to five birds in eight of the past ten populations. In the group hatched in 1948, 13 females were found to be affected.

5. *Infectious Bronchitis Control.*—(a) Respiratory diseases, especially infectious bronchitis, Newcastle disease, and chronic respiratory disease, continue to be of great economic concern to the Massachusetts poultry industry. During 1949 a total of 944 flocks was enrolled in the infectious bronchitis control program, an increase of 536 flocks over the previous year. The results on the whole continued to be satisfactory. In a few instances complications developed as the result of secondary or concurrent diseases appearing in the flock. In a small number of inoculated flocks a respiratory disease appeared several months after the inoculation, and the virus of infectious bronchitis was isolated. It is evident that not all inoculated flocks develop full protection against the virus.

(b) During 1949 a total of 384 flocks was tested for immunity to infectious bronchitis. The diagnoses for the flocks were as follows: 334 immune, 27 susceptible, 12 questionable, and 11 with both immune and susceptible birds in the same flock. The 334 bronchitis-immune flocks were also tested for Newcastle disease, yielding the following results: 88 immune, 223 susceptible, 2 questionable, and 21 with both immune and susceptible birds on the same premises. Of the 27 bronchitis susceptible flocks 18 were susceptible to Newcastle disease and the remainder were immune.

(c) Among the 724 flocks tested for Newcastle disease, using the hemagglutination-inhibition test, 425 were susceptible, 228 immune, 7 questionable, and 64 had both susceptible and immune birds on the premises.

(d) Virus isolation for a differential diagnosis in respiratory cases was attempted in consignments from 44 flocks and yielded the following results: Newcastle disease 17, infectious bronchitis 2, laryngotracheitis 2, and chronic respiratory disease 2. More than half of the cases from which the Newcastle disease virus was isolated represented flocks which had been vaccinated for the disease.

Apparently the immunity induced through vaccination was inadequate to withstand natural exposure to the virus. In the majority of cases the disease was of a mild type.

(e) Viability studies concerning Newcastle disease revealed that the virus, when seeded on various sterile test materials and stored at different temperature levels, remained viable for long periods of time. The virus seeded on down and in fresh eggs was found viable for the following periods of time when stored at the different temperature levels: incubator (37°C), 126 and 87 days, respectively; normal room (20° to 30°C), 235 and 192 days, respectively; hen house (–11° to 30°C), 255 days, refrigerator (3° – 6°C), 538 days. The viability time period listed at the refrigerator temperature represented the last test made and not the end point for the viability of the virus. The results of these investigations suggest that Newcastle virus may be highly resistant to certain environmental conditions, which may have a significant influence in the transmission and control of the disease. The results of these investigations are in press.

6. *Newcastle Disease Immunization Studies.*—(S. B. Hitchner and G. Reising.) Continued studies on the antigenic properties of a low virulent strain of Newcastle disease virus (B1 strain) showed that the wing web route of administration did not produce adequate immunity in comparison to the intranasal route. Field tests in laying flocks with this type of vaccine have demonstrated its applicability in checking outbreaks of the disease if given prior to the appearance of symptoms. The intranasal vaccination of day-old chicks, even though possessing some parental immunity, apparently increased the resistance of a high percentage of the chicks to re-exposure to the virus. Although vaccinated chicks may show low or negative serum antibody titers, laboratory tests reveal that upon re-exposure to infection most vaccinated chicks developed antibodies more rapidly than non-vaccinated chicks.

A study of the protection of chicks by passive antibodies showed that the disease could be produced in approximately 70 percent of the chicks by challenge exposure at one day of age. The results indicated that the passive protection against the disease decreased in the chicks as time elapsed from the date of vaccination of the parents, and that only those chicks from dams carrying very high antibody titers were fully protected against infection at one day of age.

During cultivation of the B1 virus in embryonated eggs it was observed that by using embryos from Newcastle immune flocks the mortality of the embryos was delayed beyond that of the embryos from non-immune flocks. Comparison of the growth rate of the virus in Newcastle disease immune and non-immune embryos demonstrated that there was very little difference in the virus concentration in the two groups even though mortality was delayed in the immune embryos.

Mastitis Testing Laboratory. (W. K. Harris and F. A. Goulet.) During the fiscal year of 1949-50 a total of 34,735 milk samples was tested. Of this number, 22,218 were from 21 State Institution herds, 922 from the University Farm Department herd, and 11,595 from 153 private herds. Included in the latter were 344 samples from one county agricultural school herd, 29 from seven goat herds, and 3,257 from nine demonstration herds. In addition to the total number of samples tested, 107 were received in a condition unsuitable for testing. Approximately 90 percent of all samples received were collected and delivered by State Department of Agriculture collectors.

The percentage of *Str. agalactiae*-infected cows in the State Institution herds has been reduced from 22 last year to 11, but the total number of mastitis-positive cows is the same, representing 39 percent of the cows tested. Three more herds

nave become free of *Str. agalactiae* infection making a total of seven. These herds contain approximately one-fourth of the cows in the 21 herds.

Since March 24, 1947, the University Farm Department herd has been given 14 complete tests, averaging 61 head per test. An average of 72.9 percent was found negative, 25.6 percent positive for mastitis other than *Str. agalactiae* infection, and 1.5 percent positive for *Str. agalactiae* infection. The first finding of the latter occurred in December, 1947, and the last in May, 1948. Prompt detection of all *Str. agalactiae*-infected cows by laboratory retesting, immediate measures taken to prevent spread of the infection, and successful mammary therapy have proved effective in eliminating the infection from the herd. Ten cows were found positive to the *Str. agalactiae* infection during this six-months period, but none have been found since. Five of the cows were slaughtered within a year after the last case was detected, but the other five remain in the herd more than two years later.

A summary of initial tests of private herds revealed an increase during the fiscal year in the percentage of infected cows. The average for the three-year period (1947-50) is 45.5 percent and represents the incidence of mastitis in the State, if it is assumed that the laboratory has received representative samples. On the same basis the incidence of *Str. agalactiae* infection is 25.0 percent, amounting to more than one-half of the positive cases. A total of 296 reports was made on samples from private herds. The average testing time (between receipt of samples and completion of report) for the year on private herd tests was three and one-half calendar days.

The county agricultural school herd has shown gradual improvement with a program of testing quarter samples at 90-day intervals during the last two years. The number of *Str. agalactiae*-infected cows has been reduced from 11 in a herd of 18 to 1 in a herd of 23.

A summary of tests made during the fiscal years 1947-50 on 37 animals from 12 goat herds reveals that only 20 percent were found positive for mastitis, and no infection with *Str. agalactiae* was found.

Three of the demonstration herds have been tested for more than a year and have increased from a total of 49 to 69 head. The percentage of *Str. agalactiae*-infected cows has been reduced from 38.8 to 4.3 and of all mastitis infections from 57.2 ot 33.3.

Observations on individual herd progress in mastitis control indicate that good management and sanitary practices are essential, with emphasis on prevention of spread and complete herd retesting in attempting to eliminate *Str-agalactiae* infection.

PUBLICATIONS

Bulletins

437 Home Freezing in Massachusetts. By William B. Esselen, Jr., Katherine M. Lawler, and Carl R. Fellers. 35 pp. illus. February 1950. (Reprinted.)

Home freezing of foods is arousing much interest. In Massachusetts freezing seems best suited as a supplement to other methods of home food preservation. Questions frequently asked by prospective home freezer owners are answered.

453 Annual Report for the Fiscal Year Ending June 30, 1949. 86 pp. August 1949.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

454 Marketing Massachusetts Potatoes. Part I. Potato Storage Facilities. By Robert A. Fitzpatrick. 32 pp. illus. January 1950.

Although Massachusetts is a deficient area in potato production, potatoes are one of the leading cash crops in the State; and the recent national experience in potato production and marketing has been duplicated, in miniature, here. This study was undertaken to contribute to a wider public understanding of the wartime and postwar developments in the local potato enterprise.

455 The Control of Some Soil-Borne Disease of Plants by Fungicides Applied to the Soil in Fertilizer. By William L. Doran. 28 pp. illus. March 1950.

The methods described for the control of such soil-borne diseases as clubroot of cabbage, smut of onion and damping-off of seedlings should be of special interest and value to growers of vegetables.

456 Heat Penetration and Processing Studies on Home-Canned Corn, Hominy, Pork and Beans, and Potatoes. By Norman W. Desrosier and William B. Esselen, Jr. 23 pp. illus. June 1950.

In response to a continuing interest in home food preservation, procedures for the home canning of hominy, pork and beans, and potatoes are presented. Factors which affect the process requirements of these low-acid foods are pointed out.

Control Bulletins

140 Inspection of Commercial Feedstuffs. By Feed Control Service Staff. 28 pp. June 1949.

This is the fifty-fifth report on feeding stuffs inspection. Included are data on the vitamin D content of fish liver oils, the carotene and riboflavin content of alfalfa meals, and the quality of ground oats, as well as other information of interest to those concerned with the production, distribution or use of feeds.

141 Twenty-ninth Annual Report of Pullorum Disease Eradication in Massachusetts. By the Poultry Disease Control Laboratory. 11 pp. July 1949.

During the 1948-49 testing season 569 chicken, turkey, and pheasant flocks were tested. A total of 1,241,500 samples was tested, of which only 0.04 percent were positive. This is the lowest percentage of positive tests for the twenty-nine years of testing. The percentage (1.55) of pullorum "breaks" in the negative flocks was the lowest for the past ten years. Furthermore, 99.1 percent of all the birds tested were located in 100 percent tested, non-reacting flocks. Massachusetts flock owners are to be complimented on the progress that is being made in establishing and maintaining pullorum-free flocks.

142 Inspection of Commercial Fertilizers and Agricultural Lime Products. By Fertilizer Control Service Staff. 19 pp. July 1949.

This is the seventy-sixth report of the Massachusetts Fertilizer Control made in accordance with Chapter 94, Sections 250 to 261 inclusive, of Massachusetts General Laws 1920, as amended by Chapter 67, Acts of 1933.

143 Seed Inspection. By Seed Control Service Staff. 32 pp. November 1949.

This report, the twenty-second in seed control service, is a record of work delegated to the Massachusetts Agricultural Experiment Station during 1949 by authority of Chapter 94 as amended by Chapter 377 of the Acts of 1946.

Meteorological Bulletins

NUMBERED CONTRIBUTIONS

724-732, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By H. N. Stapleton. 4 pp. each.

Reports of Investigations in Journals

673 Nonenzymatic browning of foodstuffs. Production of carbon dioxide. By V. M. Lewis, W. B. Esselen, Jr., and C. R. Fellers. Indus. and Eng. Chem. 41:2587. 1949.

678 Nonenzymatic browning of foodstuffs. Nitrogen-free carboxylic acids in the browning reaction. By V. M. Lewis, W. B. Esselen, Jr., and C. R. Fellers. Indus. and Eng. Chem. 41:2591. 1949.

680 Enzyme systems of canned acid foods. Effect of processing conditions of time and temperature. By Arthur M. Kaplan, William B. Esselen, Jr., and Carl R. Fellers. Indus. and Engin. Chem. 41:2017. 1949.

685 The effect of maturity and storage on germination of Butternut squash seed. By Robert E. Young. Amer. Soc. Hort. Sci. Proc. 53:345-346. 1949.

686 Inbreeding in a closed flock. By F. A. Hays and D. W. Talmadge. Genetics 34:390-394. 1949.

688 The vegetative propagation of a few species of elm. By William L. Doran and Malcolm A. McKenzie. Jour. Forestry 47 (10):810-812. 1949.

691 Reduced ascorbic acid in goat's milk. By Arthur D. Holmes, Harry G. Lindquist, and Eugene J. Finnegan. Jour. Amer. Dietet. Assoc. 26 (3): 179-181. 1950.

692 Weed control in onions grown from sets. By William H. Lachman. Amer. Soc. Hort. Sci. Proc. 54 (1949):429-434. 1950.

693 Detergent sanitizers. By W. S. Mueller. Jour. Milk and Food Tech. 12 (4):240-243. 1949.

696 Storage studies on active dried bakers' yeast. By Roy E. Morse and Carl R. Fellers. Food Tech. 3 (7):234-236. 1949.

698 Off-flavors in peaches sprayed with benzene hexachloride. By John S. Bailey, William B. Esselen, Jr., and Ellsworth H. Wheeler. Jour. Econ. Ent. 42 (5):774-776. 1949.

699 Canceled.

700 Preparation of sterile fish muscle press juice for chemical and bacteriological studies. By David W. Anderson, Jr., and Carl R. Fellers. Food Tech. 3 (8):274. 1949.

701 Chemical thinning of apples at blossom time and up to four weeks from petal fall. By F. W. Southwick and W. D. Weeks. Amer. Soc. Hort. Sci. Proc. 53:143-147. 1949.

702 Further studies on the influence of methyl a-naphthaleneacetate on ripening of apples and peaches. By F. W. Southwick. Amer. Soc. Hort. Sci. Proc. 53:169-173. 1949.

703 Some aspects of trimethylamine formation in swordfish. By David W. Anderson, Jr., and Carl R. Fellers. Food Tech. 3 (8):271-273. 1949.

704 Weeding corn with chemicals. By William H. Lachman. Amer. Soc. Hort. Sci. Proc. 54:(1949):417-428. 1950.

705 Loss of reduced ascorbic acid from riboflavin-enriched mares' milk. By Arthur D. Holmes. Food Tech. 3 (8):277-278. 1949.

707 Mortality rate in relation to egg production. By F. A. Hays. Poultry Sci. 28 (5):707-712. 1949.

708 Composition and nature of apple protein. By S. G. Davis, C. R. Fellers, and W. B. Esselen, Jr. Food Res. 14 (5):417-428. 1949.

710 Winter injury to red raspberries as affected by cultivation or mulching. By John S. Bailey. Amer. Soc. Hort. Sci. Proc. 54 (1949:197-199. 1950.

711 The nutritional status of the cultivated blueberry as revealed by leaf analysis. By John S. Bailey, C. Tyson Smith, and Robert T. Wetherbee. Amer. Soc. Hort. Sci. Proc. 54 (1949):205-208. 1950.

712 Comparison of light vs. darkness for storing Butternut squashes. By Arthur D. Holmes, Albert F. Spelman and Robert T. Wetherbee. Food Tech. 3 (8):269-271. 1949.

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745 Darkness prolongs storage life of Butternut squashes. By Arthur D. Holmes. Food Res. 15 (2):99-102. 1950.

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